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A MONOGRAPH OF THE EXISTING CRINOIDS

BY
AUSTIN HOBART CLARK

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VOLUME 1
THE COMATULIDS

PART 4a.—SUPERFAMILY MARIAMETRIDA (except the family Colobometridae)

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UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1941

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PREFACE

Parts, 3, 4, and 5 of Volume 1, Bulletin 82, include the systematic discussion of the species and higher groups of living comatulids, or unstalked crinoids. Part 3, published in 1931, included the account of the superfamily Comasteridae. Part 4a, the present part, includes the account of the superfamily Mariametrida, with the exception of the family Colobometridae.

In the preparation of Part 4a I have been under special obligations to Dr. Baini Prashad, director of the Zoological Survey of India, who has sent me for study all the specimens in the collection of the Indian Museum that I had not previously seen; to Dr. K. W. Dammerman, director of the Buitenzorg Museum, who sent me all the comatulids in the collections under his care; to Dr. H. Boschma, director of the Leiden Museum, who sent me the important collection made in the Dutch East Indies by the *Willebrord Snellius;* to Dr. W. T. Calman, C. C. A. Monro, and D. Dilwyn John, of the British Museum (Natural History), who sent me many specimens from that institution, and also the very interesting collection made by the John Murray Expedition, 1933–34, in the Indian Ocean; and to F. N. Chasen and M. W. F. Tweedie, who sent me the collection of the Raffles Museum, Singapore.

I am also under obligations to Dr. Hubert Lyman Clark, of the Museum of Comparative Zoology, at Cambridge, Mass., who as in the past has most courteously permitted me to examine the specimens under his care; to Dr. Th. Mortensen, of the Zoological Museum, Copenhagen, Denmark; to Dr. Torsten Gislén, of Lund, Sweden, for most valuable criticism and suggestions; to Dr. Maximilian Holly, of the Natural History Museum at Vienna, Austria, for detailed information regarding the specimens in the collection of which he has charge; and to Edward J. Holmes, director of the Museum of Fine Arts, Boston, Mass.

To my colleagues in the United States National Museum and to the staff of the Museum's library I owe a debt of gratitude for their unfailing kindness in assisting in various ways to clear up the many complex geographical, bibliographical, and other questions that have constantly arisen during the progress of the work.

The illustrations are almost entirely reproductions of photographs taken by G. I. Hightower under the supervision of Dr. A. J. Olmsted in the photographic laboratory of the Museum. Both Dr. Olmsted and Mr. Hightower have been unremitting in their efforts to secure the best possible results with these exceptionally difficult subjects.

The specimens figured on the plates are for the most part in the collection of the United States National Museum. Many, however, chiefly type specimens, are in other museums. These museums are: Museum of Comparative Zoology, Cambridge, Mass. (M.C.Z.); British Museum (Natural History), London, England (B.M.); Copenhagen Museum, Copenhagen, Denmark (C.M.); Hamburg Museum, Hamburg, Germany (H.M.); Museum für Naturkunde, Berlin, Germany (Berl. Mus.); Amsterdam Museum, Amsterdam, Holland; Leiden Museum, Leiden, Holland (L.M.); Indian Museum, Calcutta, India (I.M); Australian Museum, Sydney, New South Wales; and the Cairo Museum, Cairo, Egypt.

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A MONOGRAPH OF THE EXISTING CRINOIDS

By Austin Hobart Clark

INTRODUCTION

The present part, Part 4a, of Volume 1, Bulletin 82, is a continuation of Part 3 preceding. Part 3 contained the account of the superfamily Comasterida, and the present part includes the account of the second of the three superfamilies of the Oligophreata, the Mariametrida, with the exception of the family Colobometridae.

The arrangement of the families and higher groups adopted in the present work is given in Part 3, p. 65.

Keys to the families into which the superfamily Mariametrida is divided are included in the keys to the families and higher groups of the comatulids given in Part 3, pp. 69–74.

Since the portion of this monograph dealing with the structure and morphology of the comatulids was published a large amount of additional work has been done by others, particularly by Prof. Torsten Gislén, of the University of Lund, Sweden, and many interesting and important new facts have been brought to light.

Some of the interpretations of the structural peculiarities of the comatulids advanced by these authors differ more or less widely from those given earlier in this work. Though thoroughly appreciative of the vast amount of original work upon which these interpretations are based, I fail to find, upon careful analysis, any reasons for altering my opinions already expressed.

The main point of divergence between my opinions and those of my colleagues hinges upon the weight to be given the Paleozoic and earlier Mesozoic forms in an elucidation of the structure of recent types. I maintain that until the recent crinoids are far better known than they are at present, especially in regard to their younger stages, it is futile to attempt to interpret the details of their structure from comparison with earlier forms. For most of the earlier forms, as we know them, represent the terminal twigs of developmental branches of which the generalized beginnings are unknown, just as the adults of the recent forms represent the ultimate product of an unknown ontogeny. And even if the earlier stages of all the recent forms were known, it is by no means certain that these would give any definite clue to their ancestry and morphological relationships when compared with the adults of earlier types.

In my opinion the most valid and logical conclusions regarding the comparative structure and morphology of the recent crinoids are to be reached by detailed and intensive study of the recent types alone. Until we are in possession of sufficient facts to enable us to understand the recent types, and thus to be sure of our ground, we are likely to be led astray rather than aided by any detailed comparison with fossil types.

However, I believe it only fair to my colleagues to give a summary of their work and of their views, without further comment, so that future workers may be able to judge for themselves the relative merit of the various opinions expressed.

PINNULES AND ARMS

Dr. Gislén, in common with Dr. Th. Mortensen, disagrees with my interpretation of the pinnules of the recent crinoids. Mortensen said that, guided by his researches and observations on pathological and embryological material, he considered himself bound to uphold the theory of P. H. Carpenter—that pinnules correspond morphologically to dwarfed arms.

Gislén noted that Bather had stated that the only difference between pinnules and arms is that pinnules contain fertile gonads. But he pointed out that this distinction does not always exist, for many stalked crinoids and even comatulids, as for instance *Notocrinus* and *Comatula*, have fertile gonads in the arms. Furthermore, distal pinnules, and all the pinnules of the anterior radii of many comasterids, also lack fertile gonads. He said that the only difference that should be made use of in a definition of the different types of brachial ramification is that the pinnule is a small unramified arm, as a rule considerably shorter than the main arm. He noted that, so far as he had observed, the articulations between the pinnule segments in recent crinoids are always unlike those between the brachials, if the articulations between the first two segments are excepted. Syzygial articulations between the pinnulars are found in *Hyocrinus*, and also between the segments of P_2 in *Stephanometra.*

In *Hyocrinus*, as Gislén remarked, the pinnules are very long, approaching the main arm in size, and therefore the pinnule-bearing brachials may have the appearance of axillaries. When pinnules are of nearly the same size as the arms that bear them Gislén said it is a matter of opinion whether they are to be regarded as pinnules or as arms.

He concluded that the phylogenetic development has doubtless been that an isotomic type of ramification was succeeded by a heterotomic, which in its turn was replaced by a metatomic. The lateral ramifications began to appear at regular intervals, diminished in relative size, and became unramified; thus the holotomic or pinnulate type was reached. The arm of the recent crinoids, according to Gislén, should thus be regarded as a sympodium that has arisen in the following way: Right and left ramifications alternately have remained at their full development, while corresponding left and right ramifications have been suppressed into pinnules.

Gislén gave a detailed account of the phylogenetic development of pinnules from arm ramifications, based chiefly upon some of Angelin's type specimens in the Riks Museum at Stockholm.

Mortensen showed that Dr. W. B. Carpenter's account of a sympodial growth of the arm during ontogenetic development is incorrect. The pinnule segments are weaker from the very first, though on the other hand their longitudinal growth is at first more rapid.

From an examination of specimens of *Comatula pectinata* and of *Comanthus parvicirra* Gislén found that in the anterior radii the arms terminate in the manner described by Mortensen for *Antedon petasus*—the main arm always retains its character of chief branch, and the pinnules originate as small buds alternately to right and left. On the posterior arms the only difference is that the growth of the main arm is retarded, so that the pinnules reach their full size while the main arm grows not at all, or only slowly. Therefore these arms do not terminate in an axillary supporting two pinnules, but on the last segment that gives rise to a ramification there is an almost full grown pinnule, and a main arm composed of a few segments. As soon as more than one or two segments have been formed on the main arm, a new pinnule appears. The main arm, therefore, keeps its ramified character and never develops as a pinnule.

According to Gislén the obstructive or inhibitive factor that causes the formation of pinnules instead of arms may in certain abnormal cases develop two pinnules on a brachial instead of one pinnule and one main arm, or two main arms. He concluded from this that sometimes the suppressive factor may produce a reversed effect—that what ought to have been a main arm has become a pinnule, and the reverse. He regards hypertrophied pinnules as the result of removed obstruction.

Gislén classified arm regeneration in the crinoids as follows:

1. *Restorative:* Replacing of a single arm broken off; this occurs in all crinoids.

2. *Reproductive or pseudo-augmentative:* From a fracture one or more axillaries with two or more arms are reformed; thus the number of arms is the same as before the breakage. Presumably this occurs in all more or less full grown crinoids. It is called *pseudo-duplicative* when one axillary and two arms are reformed, and *pseudo-multiplicative* when several axillaries follow each other, and therefore more than two arms are reformed from a single fracture.

3. *Augmentative:* From a fracture a greater number of arms are formed than the broken limb possessed. This occurs in comatulids, and presumably also in *Diplocrinus* and *Teliocrinus*. It may be *duplicative*, when one axillary and two arms are formed from the fracture, or *multiplicative*, when several axillaries following one another, and therefore more than two arms, are formed.

4. *Reducing:* From a fracture fewer arms are regenerated than the lost limb possessed. This is theoretically conceivable, though it is not known with certainty.

Gislén said that the young of the stalked crinoids are known only in a very small number of examples, and ordinarily they are in such an advanced stage that not much can be determined regarding their method of arm augmentation.

Augmentative arm regeneration in pentacrinites probably occurs in *Teliocrinus* and also in *Diplocrinus*, according to Döderlein. The drawing of a young *Neocrinus decorus* left by P. H. Carpenter seems to show that the formation of arms from the IIBr axillary takes place in the same simple way as the formation of the two arms on the IBr axillary in the comatulid pentacrinoid—the arm tip forks into two processes that are equally favored in further growth and so develop into two new arms.

Döderlein said of the young of species of *Metacrinus* from the *Valdivia* expedition that he examined, "Ich konnte bei den jungen Exemplaren nachweisen, dass sich an einen oder dem anderen Armstrahl noch unmittelbar vor seinem Ende eine Axillare ausgebildet hatte, d. h. eine Gabelung angelegt wurde." In his somewhat earlier work on the genus *Metacrinus* in the *Siboga* report he published a figure of an arm ramification in *M. acutus* in which "die Arme auffallend ungleich sind."

Gislén said that the young of *Metacrinus* described by himself in 1922 are very instructive on this point. His observations showed distinctly that the formation of IIBr, IIIBr, and IVBr series takes place in the following way: On the simple arms certain pinnules begin to gain strength and to grow. On the sides of the strengthened pinnules new small pinnules arise, and the new arm finally reaches the same length as the main arm. The place for this strengthening of the pinnules is to be found in the region of transition between the large and rudimentary pinnules of the main arm. As that part of the arm provided with the latter is shorter the younger the individual is, it is clear that the arm ramification for the formation of IIBr axillaries will occur fairly near the tip of the arm. Therefore the main arm and the new arm are not very unequal in length there, whereas the new arms on the IIIBr axillaries, and to a still greater extent on the IVBr axillaries, are very different in length at earlier stages. Thus the lengths of a main and a side arm on a IIBr axillary (*Metacrinus interruptus*, specimen 16) are 2 and 3 mm. respectively; of two young arms from a IIIBr axillary (*M. interruptus*, specimen 17) 5 and 1 mm.; of arms from a IVBr axillary (*M. interruptus*, specimen 13) 12 and 2 mm., and (*M. nobilis tenuis*, specimen 9) 5 and 1.2 mm., or 3 and 0.8 mm.

Here, said Gislén, the factor of obstruction only succeeds in acting temporarily on the pinnule that is destined to become an arm. Thus arm ramification in *Metacrinus* is more direct and primary than in the comatulids—a pinnule is strengthened, it ramifies, and then it grows until it is equivalent to the main arm.

In the pentacrinites there is regeneration of broken arms, just as in the comatulids, and as in the latter the fracture is most often at the syzygies. When a postradial series has been broken before a last axillary, regenerates appear that are like the augmentative regenerates of the comatulids. It is only by following series in different stages of development that the difference in principle between comatulids and *Metacrinus* in the way their arms increase in number can be ascertained. Thus the pseudo-augmentative arm regeneration of which examples have been given is only of a reproductive nature.

In this connection Gislén pointed out with regard to the comatulids that reproductive arm regeneration appears in them also. It is necessary to avoid interpreting an axillary regenerate as evidence of augmentative regeneration, but the comatulids undoubtedly have augmentative arm regeneration as a means of increasing the number of their arms, whereas in *Metacrinus* the method is more direct and primitive. A forerunner of augmentative arm regeneration is reproductive arm regeneration, which occurs in *Metacrinus* together with the primitive method of augmentation.

In the more specialized comatulids the strengthening of a pinnule into an equivalent of the main arm never occurs normally, except possibly in *Comatula etheridgei* (the young of *C. rotalaria*). In these arm regeneration becomes augmentative as the surfaces of syzygies in the proximal parts of the arms acquire the power of forming axillaries with a greater number of arm branches than the lost portion of the postradial series had. The apparently simpler postradial series of the comatulids must be considered as potentially forked, but the ramification does not materialize because the factor of obstruction permanently restrains the efforts of the pinnules to develop directly into arm branches. This ramification does not appear until after the breakage of an arm (in the comatulids autotomy) when the dormant tendency is released following the inception of regeneration.

Gislén said that on an examination of the genus *Metacrinus* one is struck by the extent to which the odd numbers are more frequent than the even in the division series—that is, if the hypozygals are counted as independent segments. Among the specimens of *Metacrinus nobilis tenuis* examined by him there were in the IIBr to VBr series 233 odd to 26 even; in *M. rotundus* 217 odd to 70 even; in *M. interruptus* 372 odd to 59 even. Moreover, if the number of syzygies in the different division series are examined it is soon found that the series with an odd number almost always have an odd number of syzygies, while those with an even number have an even number of syzygies. So if syzygial pairs are considered as units, as was done by Carpenter, the division series have an even number of segments. Counted in this way, the specimens of *M. nobilis tenuis* examined had 258 series with an even number of segments and only one with an odd number; *M. rotundus* had 275 even to 12 odd; and *M. interruptus* had 422 even to 9 odd—a total of 955 even series to 22 odd.

Sperry made a curve for the variability of the IIBr and IIIBr series in *M. rotundus*, and he also gave a strong preponderance to the even series. He looked for the reason for this in the fact that pinnules on the inside of the arm are closer together than on the outside. If the number of segments is even there will be a smaller number of pinnules on the inside of the division series than on the outside. According to Gislén this observation is quite correct, but it does not give an explanation of the phenomenon. The real explanation presumably is that if there is an even number of segments (syzygial pairs counted as units) the new arm will be formed as a branch on the inside of the arm where it is more protected during its early growth than on the outside. How far-reaching this rule is may be seen from the figures given. It can also be confirmed by other facts. Gislén cited some examples of reproductive arm regeneration. Measurements of the regenerated arms show that the inner arms, even in the case of reproduction, are at first weaker than the outer (main) arms. This is explained by the rule just given, for the regenerate suggests the form that the actual ontogenetic development took. When, as sometimes happens, a new arm develops on the outer side of the main arm, the ramification often takes an abnormal form. The base of the new arm bends outward in a wide curve, and the two arms diverge not at equal angles from the main axillary, as is usually the case.

Sometimes, in spite of an uneven number of components in the series, the new arm still appears on the inner side, owing to abnormal pinnulation. According to Gislén the explanation of an abnormal number in the division series is generally that the main arm has aborted and become a pinnule, while a pinnule has hypertrophied and taken over the function of the main arm—in other words a shifting of the suppressive factor has taken place.

Gislén said that so far as can be judged from Agassiz's work on *Calamocrinus*, in this genus too it is most frequently an inner pinnule that is strengthened into an arm.

Carpenter's figure of the young of *Neocrinus decorus* shows that in this genus the new arm is formed by the splitting of the growing point. Thus it cannot be said in this case that a new arm developing on the inner side of the main arm would be more protected than one developing on the outer side. In this case, therefore, the number of even segments (syzygial pairs counted as units) in the IIBr and following series is not strikingly higher than the number of odd segments, which, to judge from the figures, occur pretty often.

Gislén pointed out that in the cyathocrinids odd and even series occur mixed. In the pentacrinites two separate series develop, one with an arm in the place of an inner pinnule, and another with an arm in the place of an outer pinnule. In *Teliocrinus,* with its division series composed of few elements, the new arm is usually, though by no means always, in the place of an inner pinnule. In *Diplocrinus,* on the other hand, the number of segments in the division series is odd (counting syzygial pairs as units), and the new arm is therefore in the place of an outer pinnule. The genus *Cenocrinus* to some extent forms a link between *Neocrinus* and *Metacrinus,* since the outer series of divisions seem usually to have an even number of segments, while the inner have an odd number.

Among the comatulids, according to Gislén, it is only in the subfamily Capillasterinae of the family Comasteridae that the form of pinnulation appearing in the genera *Metacrinus, Teliocrinus,* and *Neocrinus* and represented by the formula 3(2+3) reappears. So far as pinnulation is concerned this type is to be compared with division series of 4(3+4) or 4(1+2, 3+4), though there the first syzygial pair has coalesced into a single ossicle. All the other comatulids have either two or four components in their division series. In regard to pinnulation these are to be considered as one and two ossicles, respectively, since segments 1 and 3 in the division series never have pinnules. Thus in the former case the new arm must be considered as having developed on the outside of the main arm, in the latter case on the inside.

The indifference as to whether it is an outer or an inner pinnule that is developed into an arm that is found in certain pentacrinites, which is to be explained by the shortening of the division series, recurs in certain primitive families of comatulids. Thus in the family Charitometridae there are about as many forms with two as with four components in the division series. The mixed type is also found in the Capillasterinae, Comasterinae, and Zygometridae (in the last two with a tendency for four components to predominate), and in the Calometridae and Thalassometridae (though most of the genera in the last two families have division series of two elements). The family Himerometridae has almost exclusively forms with four components in the division series, while the Comactiniinae, Mariametridae (including the Stephanometridae), Colobometridae, and Antedonidae have taken the other path and have practically always two elements in the division series.

As the division series here have few elements, the young arms will be situated near the base of the arms. As in the case of *Neocrinus decorus* an inner pinnule is not more protected during development than an outer pinnule. Moreover, in the comatulids direct increase in the number of arms has been replaced by augmentative regeneration, and the small arm regenerates, hidden between the bases of the arms, are not very much exposed to breakage. In Gislén's opinion this must be taken to be the explanation of the indifference to the number of segments in the division series. In the tendency of the axillaries to shift toward the proximal part of the arms, a tendency that can be traced in the form series of all crinoids, there is this advantage—if the arms are exposed to a bending that will result in fracture, these fractures will occur distally to the axillaries, and will therefore affect only single arms. On the other hand, in *Metacrinus* and forms of a similar type whole clusters of arms are easily broken off, and so there is a greater percentage of loss of ambulacral furrow.

Occasionally in the comatulids also there occurs a direct strengthening of pinnules to an equality with arms. In a case of this kind in *Antedon petasus* described by Mortensen (1920) in 5 arms out of 10 both P_1 and P_a have developed into more or less complete pinnule-bearing arms, P_a being often stouter than P_1. In another individual examined by Gislén P_1 on the left anterior ray had developed into an arm 75 mm. long that was as stout as the other arms. From the sixth brachial, where the pinnules begin on the hypertrophied P_1, there are stout segments and oblique articulations, as on the other arms. Syzygies of normal appearance and distribution also occur, the distal intersyzygial interval being 3 muscular articulations. Gislén noted that a similar case, possibly normal, is found in the so-called *Comatula etheridgei*. If *C. etheridgei* (see Part 3, p. 309) is the young of *C. rotalaria* there is here direct arm development like that in *Metacrinus*.

In a specimen of *Cyllometra pulchella* (=*manca*) from Mortensen's collection (station 10) the right posterior radius has a normal undivided arm on the right; on the left there is a IIBr 3 series, the external arm from this being normal with a synarthry between brachials 1 and 2, syzygies between brachials 3+4 and 15+16, and the first pinnule on the second brachial, and the internal arm having syzygies between brachials 1+2 and 16+17, and the first pinnule on the fourth brachial. Gislén recalled that Springer described a specimen of *Uintacrinus socialis* with 11 arms, as the result of the development of a P_a into an arm.

Gislén said that occasionally, for one reason or another, pinnules develop directly into arms in more distal portions of the arms also. He cited a specimen of *Asterometra anthus* in which on the right arm of one of the postradial series the seventh brachial is axillary, the pinnule having developed into an arm with syzygies between brachials 4+5, 12+13, 19+20, and 27+28, a pinnule on each side of the third brachial, but the pinnules following normally distributed. At the point where the arm divides an entoparasitic gastropod is encysted, and Gislén suggested that it was possibly the irritation caused by the parasite that stimulated the pinnule to develop into an arm, though he noted that many other specimens of the same species had encysted gastropods without arm division having taken place. For some reason or other there are no soft parts on the eighth-twelfth brachials, though the distal part of the original arm still has an ambulacral furrow. He said that this is the most probable cause of the hypertrophy of P_3 on the original arm. The flow of body fluids to the distal parts of the main arm has been cut off, and P_3 has received the surplus and so has developed into a complete arm. It is to be noted, however, that no such abnormal flow of body fluids can be adduced in the three cases following.

In a specimen of *Comanthus pinguis* from Mortensen's station 10 one postradial series has two IIBr 4(3+4) series; the inner arms from each of these are undivided. One of the outer arms has a IIIBr 4(3+4) series, the other a IIIBr 8(3+4, 5+6, 7+8) series.

In a specimen of *Cyllometra pulchella* (=*manca*) from Mortensen's station 10 one ray bears an undivided arm on the right and a IIBr 8(3+4) series on the left.

In a specimen of *Neometra multicolor* from Mortensen's station 24 one postradial series has two IIBr 2 series, that to the left bearing two normal undivided arms and that to the right bearing externally a normal undivided arm and internally a IIIBr 11 (3+4) series, on which the outer arm has the proximal syzygies between brachials 4+5, 9+10, 13+14, and 17+18, and the inner has them between brachials 2+3, 7+8, and 11+12.

Gislén said that in the first two cases it is an inner pinnule that has developed into an arm. The first example is perhaps the most remarkable, presenting a picture of the repetition, so far as possible normal, in more distant parts of the arm of the proximal arm ramification and its distribution of nonmuscular articulations.

Gislén noted that Mortensen (1920) has described a case of P_3 developing into an arm in *Antedon petasus,* and that the author has described and figured an arm of *Thaumatocrinus* sp. forked twice in its distal portion. The proximal fork, he said, seems to be due to a mere splitting of the growing point, but the distal branch seems to have been caused by an hypertrophied pinnule.

Gislén said we have already seen how the new arms in the genus *Metacrinus* develop in normal cases on the inner side of a main arm, and asks: What, then, is the condition at the first ramification, the IBr axillary? Here there can be no question of the new arm developing on the inner side of an arm branch. A comparison of the material that has been considered shows that in a great majority of cases it is the right hand pinnule that has been strengthened and has become equivalent to the main arm, corresponding to a IBr 7(1+2, 4+5) series in *M. interruptus.* In 9 specimens of *M. nobilis tenuis* the right pinnule is strengthened into an arm in 24 cases, the left pinnule in 11. In 7 specimens of *M. rotundus* 25 right and 11 left pinnules are strengthened into arms. In 19 specimens of *M. interruptus* 73 right and 15 left pinnules are developed into arms. In all 122 right pinnules as against 37 left pinnules have been strengthened. Gislén said that the reason for this may be ascertained. In by far the greater number of cases the first pinnule is on the right side of the second brachial—in other words it is the right branch that is suppressed at the first ramification. When the first real arm ramification at last takes place, it is on the right side that the suppressed impulse to arm formation is stronger, and therefore it is oftener a right than a left pinnule that develops into an arm. In 9 specimens of *M. nobilis tenuis* P_1 is on the right side of the second brachial in 24 cases out of 35, in 7 specimens of *M. rotundus* in 26 cases out of 30, and in 21 specimens of *M. interruptus* in 85 out of 100—in all, in 135 cases out of 165. Thus it is the right arm that is suppressed in the genus *Metacrinus.*

In the genera of the family Hyocrinidae, according to Gislén, *Calamocrinus* has its first arm ramification after the first pinnule, while the other genera have simple arms. Examples of the arm base in *Calamocrinus* up to and including the first axillary are: IBr 10(1+2, 5+6, 7+8), with pinnules on brachials 4 (left), 6, 8, 9; and IBr 10 (1+2, 5+6, 8+9), with pinnules on brachials 4 (left), 6, 7, 9. The first pair of pinnules is thus completely suppressed, and the first pinnule develops in the great majority of cases to the left of the fourth brachial—the suppressed first pinnule would also have appeared on the left (of the second brachial) if it had developed. The first arm ramification is also usually caused by the strengthening of a left pinnule. Thus here also there is a connection between the development of the first pinnule and of the first arm ramification similar to that which may be made out in the genus *Metacrinus.*

The difference is that P_1 and the first arm ramification developed to the right in *Metacrinus*, while they are found on the left in *Calamocrinus*.

The other genera of the family Hyocrinidae are, like *Calamocrinus*, defective in their pinnulation. Information regarding the position of the pinnules is sporadic and incomplete. A reconstruction of the defective rows of pinnules shows, however, that in the great majority of cases the suppressed P_1 must have been on the left of the second brachial. A specimen of *Ptilocrinus pinnatus* examined had, up to the eleventh brachial, on all five arms syzygies between brachials 1+2, 5+6, and 8+9, with pinnules on brachials 4 (left), 6, 7, 9, 10, and 11. Of *Gephyrocrinus* there are only three specimens known. The pinnulation and distribution of the syzygies in the arm bases up to and including the sixth brachial are for the most part as in *Ptilocrinus*. The first pinnule is on the fourth brachial. According to the description and figures the first (suppressed) pinnule was on the left of the second brachial in 10 cases out of 11. In *Thalassocrinus* the first developed pinnule is on the fifth brachial, and on the left. In *Hyocrinus bethellianus* the first pinnule is on the left of the sixth brachial. According to Gislén Carpenter's figure of this species is reversed.

In the Phrynocrinidae the genus *Naumachocrinus* is known only from a single very defective specimen. In *Phrynocrinus* the first arm ramification is at about the twentieth–twenty-fifth brachial. The lowest pinnule is on the seventh or eigth brachial, to the right in two cases and to the left in three. A reconstruction of the pinnulation on the five rays of the only known specimen of *Phrynocrinus nudus* shows that the (suppressed) P_1 was on the right of the first epizygal in three cases, and on the left in two.

The family Bathycrinidae is represented in the recent seas by six genera, of which three have 10 arms with IBr series of two elements, and three have five undivided arms—*Rhizocrinus*, *Bythocrinus*, and *Democrinus*.

The genera of Bathycrinidae fall into two series, one with short and coalesced basals, the other with very long basals joined by suture. Gislén remarked that it is interesting to note that the position of the first pinnule is different in these two series.

In *Rhizocrinus lofotensis* the first developed pinnule appears almost always on the eighth brachial, and usually to the right—in 22 cases out of 30 in specimens from the Trondhjem Fjord. P_1 would therefore, if developed, usually appear on the left of the second brachial.

In the genus *Bythocrinus*, on the other hand, the arrangement is different. In *Bythocrinus* cf. *braueri* in the four specimens studied the first pinnule in 9 cases out of 11 appears to the left on the fourth brachial, or to the right on the sixth brachial. Therefore P_1 would, if developed, usually appear on the right of the second brachial.

In the comatulids four genera have undivided arms. In the only one of these four genera belonging to the oligophreate type, *Eudiocrinus*, the first pinnule is invariably on the left, whereas of the three remaining genera, belonging to the Macrophreata, at least two have the first pinnule to the right in the great majority of cases.

The three macrophreate genera with undivided arms are *Thaumatocrinus*, with 10 arms, and *Pentametrocrinus* and *Atopocrinus*, each with 5 arms.

In *Thaumatocrinus* Gislén found that the first pinnule is as often to the right as to the left in the species he was able to study. In the specimen of *T. jungerseni* in the Upsala Museum P_1 is on the right of the second brachial in five cases out of nine.

In 10 additional specimens in the Copenhagen Museum the first pinnule is on the right of the second brachial in 50 cases, and on the left in 48. Gislén said that it might be supposed this peculiarity might be accounted for by the genus being 10-rayed; but the same distribution may also be seen in the 5-rayed young. In *Thaumatocrinus renovatus* P$_1$ appears to the right of the second brachial in three cases and to the left in two. The position of P$_1$ also varies in a young individual of *T. jungerseni*.

In *Pentametrocrinus* and *Atopocrinus* the first syzygy is usually between brachials 4+5, and the first pinnule is on either the second or the fifth brachials.

Carpenter said that in *Pentametrocrinus japonicus* the lowest pinnule (on the fifth brachial) appeared to the right in 11 cases out of 12. P$_1$ also appeared to the right on the second brachial in *P. varians*. It is also stated to be commoner on the right than on the left in *P. semperi*. Gislén examined two specimens of *P. diomedeae;* in these the lowest pinnule was on the right in 9 cases out of 10. Judged from Koehler's figures the same seems to be the case in *P. atlanticus*. In *Atopocrinus sibogae* P$_1$ in 4 cases out of 5 is to the right on the second brachial.

Gislén gave some examples of the suppression of a right or a left arm in other comatulids. The examples given showed a tendency for the suppression to be located differently in certain oligophreate families on the one hand and certain macrophreate types on the other.

In a 9-armed specimen of *Comatula pectinata* from Java the left arm, as in *Eudiocrinus*, is rudimentary. It is represented by a small calcareous lump of two ossicles united by syzygy. The right arm has the first 6 brachials united in 3 syzygial pairs.

Springer described a 9-armed specimen of *Uintacrinus socialis* in which a left arm is suppressed into a pinnule.

Gislén found a similar case in a 9-armed specimen of *Antedon petasus*. On the undivided arm the second and third ossicles are united by synarthry, and the fourth and fifth and tenth and eleventh are united by syzygy. The undivided arm is as stout as the others. On both sides of the arm the first gonad is on the third pinnule. The unusual distribution of nonmuscular articulations is the same as in the specimen of *Uintacrinus socialis* just mentioned. According to Gislén these cases may be explained in two ways—either the reduction has gone so far that both the suppressed arm and the ossicle to which it was attached have disappeared, or the arm alone has been suppressed, the IBr$_1$ and IBr$_2$ having been coalesced into a single ossicle. Since there is a muscular articulation between the first and second ossicles following the radial, the second alternative is believed by Gislén to be the more probable. In one of these cases it is clearly a right arm and in the other a left arm that has been suppressed. Gislén said it is to be desired that more data regarding the pinnulation of similar forms with undivided postradial series should be made available in order to enable us to decide whether the tendency to suppression is more frequent in one or the other, or, as in *Thaumatocrinus*, equally frequent in both.

Gislén noted that during ontogenetic development the first arm ramification is formed by two equally stout arms. Sometimes, however, it seems that a difference in length between the two arms which is very insignificant, and in the larger young soon disappears, arises, at least in certain cases. Thus we have here a difference in length between the two arms of a pair, not a difference between pairs of arms such as is illustrated and described by Perrier. This last, indeed, seems not to occur. The slight differences between the two arms of a pair has heretofore scarcely been discussed, only occasionally illustrated, and possibly sometimes overlooked, because of its transitory nature. Mortensen, indeed, denied it. When it is marked it seems to be strongest in arms with from 10 to 15 brachials.

Observations made by Gislén on very young individuals of *Asterometra anthus* and *Stenometra dentata* point to the conclusion that one arm, usually the right arm, is less favored in the earlier stages of development. It seemed possible to Gislén that in reproductive arm regeneration the growth of one or the other arm might be more or less favored, and that this might open up a possibility of drawing certain conclusions regarding the tendency to suppression. In order to determine whether this could be established for regenerates from the IBr_1 Gislén carried out experiments in regeneration with *Antedon petasus* at the Kristineberg station. Owing to a number of unfortunate accidents he obtained only 10 individuals with regenerated arms out of all the hundreds operated upon.

In 1918 he amputated the postradial series between the IBr_1 and IBr_2 in 15 individuals. The animals so treated were placed in a fairly large box with a lid perforated with holes 10 mm. in diameter. The box was sunk off Blåbergsholmen, Kristineberg, at a depth of about 15 meters and was anchored by a line to a crevice in a rock just above high-water mark. When it was taken up a month later it was found that all the individuals but one had escaped through the perforations. Fine-meshed netting was then nailed over the perforations, and in 1919 the box was again placed in position, this time with 50 amputated individuals. The strong September storms, however, tore away the cable, and the box was lost.

In 1922 the same procedure was repeated with a new box, but the circulation within the box was too weak and the animals died. In 1923 he secured nine individuals with regenerated arms. The regenerates obtained, however, did not give a final solution to the problem, even though they furnished certain indications. The specimen obtained in 1918 had the anterior ray amputated. Of the two regenerated arms the left was 1.5 mm. long, with 8 (9) brachials, and the right was 1.2 mm. long, with 7 brachials. But an opposite result was shown by one of the nine regenerates obtained in 1923. In this also the anterior postradial series is regenerated. The left arm is distinctly the shorter, 1.4 mm. long, with 10 brachials, the right arm being 1.6 mm. long, with 11 brachials. No pinnules have developed. Four other individuals showed either no difference or an almost imperceptible difference in the length of the arms. The first of these, with the right posterior postradial series amputated, had 3 brachials on each side of the regenerated IBr axillary. The other three, two with the anterior and one with the left anterior ray regenerated, had almost exactly equal arms with from 15 to 20 brachials, supplied with from two to four pairs of minute pinnules distally. About 12 proximal brachials lacked pinnules, as in the young, though sometimes there were rudiments of P_1 and P_a. Of the four remaining regenerates three had only three or four regenerated segments developed. In two of these the regenerated ray was the left anterior, and in one it was the anterior A minute ramification consisting of a single segment appeared in one case to the right, and in one case to the left. The last individual had regenerated in the left anterior radius an undivided arm 2.5 mm. long with the tip bent to the left consisting of about 11 segments.

Gislén said that judged from the slight available information regarding undivided arms in *Antedon* the indications are that there is here the same variability as in *Thaumatocrinus*.

In summing up Gislén said that if the first ramification is suppressed this process occurs differently in different families, but with a certain regularity in closely related forms. Usually it can then be demonstrated how the tendency to suppression affects predominantly either the right or the left ray, which becomes a pinnule or disappears altogether. If the arm is defective in its pinnulation the first pinnule and, beyond, the first arm branch, appear as a rule on the same side of the arm as that on which the suppressed first pinnule would have been according to the reconstruction.

In the family Hyocrinidae usually both the suppressed and the lowest pinnule, and in *Calamocrinus* the first arm ramification, are to the left.

Among the pentacrinites *Metacrinus* has both the lowest pinnule and the first arm branch to the right.

In the Phrynocrinidae too little material is available to permit judging the position of the first pinnule.

The family Bathycrinidae may be divided into two natural groups. To one group belongs *Rhizocrinus*, which has the first developed pinnule to the right on the eighth brachial, though the suppressed first pinnule was to the left on the second brachial. According to Gislén this type is the only exception to the rule that the lowest pinnule appears on the same side of the arm as the suppressed first pinnule. In the other group, exemplified by *Bythocrinus*, the suppressed first pinnule is usually to the right.

Among the comatulids, in *Eudiocrinus* P_C, the lowest pinnule, is on the left. Where arms have been suppressed a similar tendency seemed also to show itself in a few examples in the families Comasteridae and Uintacrinidae. An opposite tendency is seen in *Pentametrocrinus* and *Atopocrinus* in which P_1 usually appears to the right. In some young of certain species of Thalassometridae the right arms were often for a time more weakly developed than the left. In the genus *Thaumatocrinus* the position of P_1 is variable, and this is also the case in a few individuals of *Antedon petasus* with undivided postradial series. Regenerates of this species pointed in the same direction.

Gislén said that a connection, in the sense that the families having their lowest pinnule developed in the same way are more closely related, can not be assumed if there are no further facts forthcoming to support such a supposition. He remarked that the Thalassometridae and certain Macrophreata agree in a number of features, and it is probable that they are rather closely related. Possibly also, according to Gislén, *Thaumatocrinus* is more closely related to the Antedoninae than it is to *Pentametrocrinus*.

At least the majority of the comatulids presumably have not developed from forms with undivided postradial series. It may be supposed that forms with undivided postradial series arose in different comatulid families at different times, and are thus only parallel types. The fact that in certain Zygometridae (*Eudiocrinus*) and in the Comasteridae and Uintacrinidae the left arm branch is less strongly developed or suppressed, and in certain Macrophreata and in some of the Thalassometridae it is the right arm branch that is less strongly developed or suppressed seemed to Gislén to support Kirk's assumption that the comatulids are of polyphyletic origin.

REVERSIBILITY OF DEVELOPMENT

Gislén maintained that pinnulate forms have developed phylogenetically from nonpinnulate types with extensive arm ramification. The holotomic recent types are descended from the metatomic. Pinnules are thus simplified armlets or ramiculi. That the tendency toward arm ramification is in all cases present, though it may be latent, is shown by the fact that pinnules in certain cases abandon their character of small unramified arms and develop into complete arms with pinnules. Gislén said the appearance of pinnules can most easily be explained by assuming the existence of obstructive factors on the removal of which the pinnule again develops into a ramified arm, the phylogenetic development having presumably involved a great number of obstructive mutations. From this point of view the appearance of axillaries with two pinnules and cases of abnormal pinnulation otherwise difficult to explain are easily accounted for as examples of two sided and reversed obstruction respectively. In *Metacrinus* also obstruction of a temporary nature may be said to occur, retarding the development of the inner arms so that they remain in the form of pinnules for a fairly long time.

Dollo in 1893 laid down the law of irreversibility of development, which was later formulated by Abel as follows: "An aborted organ never recovers its former strength, and an organ that has disappeared never reappears—at least not developed in the same way." Gislén said that, broadly speaking, this rule is certainly correct. But it is also clear that the facts recorded and the conclusions to which they lead suggest that exceptions may be found to Dollo's law. From the point of view of heredity it may be maintained that Dollo's law is valid if the tendency to an organ has really disappeared—in that case a return to the original type would be out of the question. When a return really appears this may be interpreted as the removal of a factor of obstruction. Gislén said that this idea might perhaps be considered from the paleontological standpoint as rather perilous, though in reality it is not. As a matter of fact such reversibility presumably occurs very seldom in nature. The reason for this would seem to be that the type of organization reached is the one that is most suitable from the point of view of selection and structure, and most economical; and it has often been reached in a roundabout way by an infinity of adaptations.

That in certain cases the conditions necessary for "Rückschläge" really occur is shown, however, by the specimen with hypertrophied pinnules. Hypothetically the conditions might be pictured thus. In any collection of some thousands of comatulids there are always a number with one or another of their pinnules replaced by a more or less ramified arm. Thus in 270 specimens of *Antedon petasus* that Gislén secured at a single haul of the dredge off the Kristineberg zoological station at Flatholmen, three showed abnormal arm ramification. Assuming that these variations were of any advantage from the point of view of selection, and provided that they were inheritable, the old character would appear normally in all individuals after some few generations.

Gislén said that there seems actually to be a good example of a reversion of this kind in the phylogeny of the comatulids. At one time, toward the end of the Paleozoic, the proximal pinnules were suppressed by the disk, which rose high up between the arms. They reappeared when the disk again retreated. But, according to Gislén, there is still a relic of this development in the gap that appears in the pinnulation of young comatulids, though in most fully grown individuals it is filled in by the subsequent development of the proximal pinnules.

MUSCULAR ARTICULATIONS

Gislén studied in great detail the brachial articulations of the crinoids and their significance, his conclusions differing somewhat from mine. He pointed out that when examining the obliqueness of an articulation two different kinds of obliquity must be distinguished. If an arm be viewed from the dorsal side it is noticed at once that the lines that mark the articulations do not run at right angles to the longitudinal axis of the arm, but cross the arm more or less obliquely. This Gislén called exterior obliqueness. On the articular faces of the brachials the dorsoventral crest and the transverse (fulcral) ridge do not usually meet at a right angle, with the result that the muscles and interarticular ligaments of the two sides are not of the same size. This he called interior obliqueness.

A straight muscular articulation is characterized by two points of contact at the same distance from the mediodorsal line; an oblique muscular articulation has a distinct dorsolateral point of contact, and a less distinct ventrolateral one. This difference is obvious only in those types in which the course of the articular lines across the dorsal surface of the arm is fairly oblique; in those comatulids in which the articular lines run nearly at right angles to the longitudinal axis of the arm it is indistinct, or not visible at all. As this feature stands in a certain relation to the exterior obliqueness of the brachials, Gislén believed that there would be a certain amount of interest in ascertaining the degree of obliqueness in the course of the articular lines across the dorsal side of the arms in the comatulids.

Comissia parvula, arms 45 mm. long: (15)[1] 17 brachials 1.1 mm. broad in each 10 mm. in the proximal part of the arm, and (12) 15 brachials 0.6 mm. broad in the distal; relation of longer side of the brachials to width 1:1 to 3:2 angle of the distal articulations with the longitudinal axis of the arm 66–72°.

Comissia peregrina magnifica, arms 160 mm. long: (9) 12 brachials 2.5 mm. broad in each 10 mm. in the proximal part of the arm, and (12) 16 brachials 1.2 mm. broad in the distal; relation of longer side of the brachials to width 1:2 to 2:3; angle of the distal articulations with the longitudinal axis of the arm 69–77°.

Comatula solaris, arms 100+mm. long: (9) 10 brachials 3.5 mm. broad in each 10 mm. in the proximal part of the arm, and (13) 15 brachials 2.0 mm. broad in the distal; relation of longer side of the brachials to width 1:2; angle of the distal articulations with the longitudinal axis of the arm 72–76°.

Comatula pectinata, arms 70 mm. long: Relation of longer side of the brachials to width 2:3; angle of the distal articulations with the longitudinal axis of the arm 67–79°.

Capillaster sentosa, arms 80 mm. long: (11) 11 brachials 2.4 mm. broad in each 10 mm. in the proximal part of the arm, and (13) 15 brachials 1.7 mm. broad in the distal; relation of longer side of the brachials to width 1:2; angle of the distal articulations with the longitudinal axis of the arm 80–89°.

Comantheria delicata grandis, arms 105 mm. long: (7) 8 brachials 3.0 mm. broad in each 10 mm. in the proximal part of the arm, and (11) 14 brachials 1.3 mm.

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[1] The figures in parentheses show the number of segments when the syzygial pairs are counted as units.

broad in the distal; relation of longer side of the brachials to width 1:2 to 2:3; angle of the distal articulations with the longitudinal axis of the arm 73–82°.

Comanthus japonica, arms 120 mm. long: (9) 10 brachials 2.4 broad in each 10 mm. in the proximal part of the arm, and (18) 22 brachials 1.6 mm. broad in the distal; relation of longer side of the brachials to width 1:5 to 1:4; angle of the distal articulations with the longitudinal axis of the arm 87–90°.

Zygometra elegans, arms 105 mm. long: (16) 16 brachials 1.7 mm. broad in each 10 mm. in the proximal part of the arm, and (22) 24 brachials 1.3 mm. broad in the distal; relation of longer side of the brachials to width 1:4; angle of the distal articulations with the longitudinal axis of the arm 82–90°.

Eudiocrinus loveni, arms 45 mm. long: Proximal brachials 1.4 mm. broad; (11) 14–15 brachials 0.8 mm. broad in each 10 mm. in the distal part of the arm; relation of the longer side of the brachials to width 1:1 to 6:5; angle of the distal articulations with the longitudinal axis of the arm 75–80°.

Amphimetra tessellata, arms 120 mm. long: (11) 13 brachials 2.4 mm. broad in each 10 mm. in the proximal part of the arm, and (25) 28 brachials 1.5 mm. broad in the distal; relation of longer side of the brachials to width 1:5; angle of the distal articulations with the longitudinal axis of the arm 86–90°.

Himerometra magnipinna, arms 105 mm. long: (13) 13 brachials 1.7 mm. broad in each 10 mm. in the proximal part of the arm, and (22) 23 brachials 0.8 mm. broad in the distal; relation of longer side of the brachials to width 1:4 to 1:3; angle of the distal articulations with the longitudinal axis of the arm 81–89°.

Stephanometra spicata, arms 130 mm. long: (11) 12 brachials 1.5 broad in each 10 mm. in the proximal part of the arm, and (15) 16–17 brachials 1.1 mm. broad in the distal; relation of longer side of the brachials to width 1:2; angle of the distal articulations with the longitudinal axis of the arm 78–87°.

Liparometra grandis, arms 120 mm. long: (13) 14 brachials 2.0 mm. broad in each 10 mm. in the proximal part of the arm, and (16) 18 brachials 1.2 mm. broad in the distal; relation of longer side of the brachials to width 1:4 to 1:3; angle of the distal articulations with the longitudinal axis of the arm 82–89°.

Cenometra bella, arms 90 mm. long: (17) 20 brachials 0.8 mm. broad in each 10 mm. in the distal part of the arm; relation of the longer side of the brachials to the width 2:3 to 3:4; angle of the distal articulations with the longitudinal axis of the arm 78–82°.

Cyllometra disciformis (=*manca*), arms 90 mm. long: (14) 17 brachials 1.2 mm. broad in each 10 mm. in the proximal part of the arm, and (15) 20 brachials 0.7 mm. broad in the distal; relation of the longer side of the brachials to width 1:1 to 4:3; angle of the distal articulations with the longitudinal axis of the arm 72–82°.

Tropiometra encrinus, arms 105 mm. long: (9) 11 brachials 2.2 mm. broad in each 10 mm. in the proximal part of the arm, and (14) 16 brachials 1.0 mm. broad in the distal; relation of the longer side of the brachials to width 3:4; angle of the distal articulations with the longitudinal axis of the arm 80–85°.

Pectinometra flavopurpurea, arms 65 mm. long: (12) 13 brachials 1.0 mm. broad in each 10 mm. in the proximal part of the arm, and (15) 17 brachials 0.7 mm. broad in the distal; relation of the longer side of the brachials to width 5:6 to 1:1; angle of the distal articulations with the longitudinal axis of the arm 64–72°.

Asterometra anthus, arms 85 mm. long: (12) 14 brachials 1.6 mm. broad in each 10 mm. in the proximal part of the arm, and (15) 18 brachials 1.1 mm. broad in the distal; relation of the longer side of the brachials to width 1:2 to 2:3; angle of the distal articulations with the longitudinal axis of the arm 69–77°.

Diodontometra bocki, arms 60 mm. long: (11) 12 brachials 1.3 mm. broad in each 10 mm. in the proximal part of the arm, and (14) 15 brachials 0.7 mm. broad in the distal; relation of the longer side of the brachials to width (3:4 to) 1:1; angle of the distal articulations with the longitudinal axis of the arm 69–75°.

Antedon petasus, arms 75 mm. long: (12) 15 brachials 1.2 mm. broad in each 10 mm. in the proximal part of the arm, and (14) 17 brachials 1.0 mm. broad in the distal; relation of the longer side of the brachials to width 1:1; angle of the distal articulations with the longitudinal axis of the arm 64–75°.

Heliometra glacialis, arms 200 mm. long: (7) 9 brachials 3.2 mm. broad in each 10 mm. in the proximal part of the arm, and (12) 15 brachials 1.5 mm. broad in the distal; relation of the longer side of the brachials to width 1:2 to 2:3; angle of the distal articulations with the longitudinal axis of the arm 68–78°.

Poliometra prolixa, arms about 100 mm. long: (9) 12 brachials 1.6 mm. broad in each 10 mm. in the proximal part of the arm, and (11) 14 brachials 1.0 mm. broad in the distal; relation of the longer side of the brachials to width 1:1; angle of the distal articulations with the longitudinal axis of the arm 66–74°.

Pentametrocrinus diomedeae, arms 90 mm. long: (10) 13 brachials 0.6 mm. broad in each 10 mm. in the proximal part of the arm, and (11) 14 brachials 0.5 mm. broad in the distal; relation of the longer side of the brachials to width 3:2 to 2:1; angle of the distal articulations with the longitudinal axis of the arm 59–66°.

Gislén said this study showed that distinctly oblique articulations, that is, articulations in which the articular line makes an angle with the longitudinal axis of the arm of from 59° to 79° (average 71°), are found in the Comasteridae (exclusive of the Comasterinae and *Capillaster*), Thalassometridae, Charitometridae, and Calometridae, and in the Macrophreata; while on the other hand indistinctly acute to right angles of from 72° to 90° (average about 83°) are found in the Comasterinae, *Capillaster*, the Zygometridae, Himerometridae, Mariametridae (including the Stephanometridae), Tropiometridae, and Colobometridae.

He said that from the figures given it may also be seen that the number of brachials for each 10 mm. and their relative length has a certain relation to the thickness of the arms—that is, generally with the size of the animal. In the majority of cases, however, the greatest number of segments in each 10 mm. and the shortest segments without comparison are found in the group in which the articular line makes nearly a right angle with the longitudinal axis.

The figures given are from the middle or distal parts of the arms. The figures following give the size of the angles in the proximal parts of the arms. As in the previous cases the figures are taken from the distal borders of the brachials and refer to the angles of the pinnulate side. Figures omitted denote hypozygals.

Comanthus japonica: $IIBr_2$–80°; $IIIBr_2$–78°; brachials 1–110°; 2–87°; 4–84°; 5–90°; 6–84°; 7–80°; 8–78°; 9–76°; 10–78°; 11–78°; after the twenty-third brachials the angles are larger, up to 85° or 90°.

Eudiocrinus loveni: IBr$_2$–89°; brachials 2–88°; 4–85°; 5–83°; 6–74°; 7–69°; 8–60°; 10–69°; 11–64°; 13–66°.

Amphimetra tessellata: Brachials 2–86°; 4–92°; 5–96°; 6–100°; 7–101°; 8–95°; 10–90°; 11–87°; 12–84°; 13–83°; 14–88°; then (81°–) 86–90°.

Pontiometra andersoni: Brachials 2–88°; 4–91°; 5–92°; 6–94°; 7–93°; 8–93°; 9–90°; 10–89°; 11–85°; 12–78°; 13–74°; 14–80°; distal brachials 80–90°.

Pectinometra flavopurpurea: Brachials 2–80°; 4–80°; 5–80°; 6–78°; 7–78°; 8–76°; 9–76°; 10–71°; 11–72°; 12–73°; 14–72°.

Asterometra anthus: Brachials (1—about 100°); 2–84°; 4–87°; 5–92°; 6–95°; 7–87°; 8–84°; 9–77°; 10–69°; 12–71°; 13–70°.

Diodontometra bocki: Brachials 2–83°; 4–86°; 5–87°; 6–93°; 7–96°; 8–97°; 9–93°; 10–91°; 11–90°; 12–81°; 13–78°; 14–73°; 15–75°; 16–73°.

Clarkometra elegans: Brachials (1–103°); 2–68°; 4–87°; 5–105°; 6–106°; 7–83°; 8–60°; 10–69°; 11–65°; 12–64°; 13–62°; 15–65°; then about 64°.

Heliometra glacialis: Brachials 2–67°; 4–87°; 5–95°; 6–105°; 7–106°; 8–108°; 10–108°; 11–96°; 12–87°; 13–75°; 15–82°; 16–70°; 17–74°; then about 70°.

Hypalometra defecta: Brachials 2–78°; 4–96°; 5–100°; 6–97°; 7–86°; 8–80°; 10–62°.

Thaumatocrinus jungerseni: Brachials 2–98°; 3–101°; 5–93°; 6–90°; 7–86°; 8–82°; 9–77°; 11–62°; 12–63°; 13–58°; 14–63°; 15–61°; 17–60°.

Pentametrocrinus diomedeae: Brachials 2–98°; 3–98°; 5–88°; 6–84°; 7–80°; 8–78°; 10–60°; 11–66°; 12–53°. In a larger specimen: Brachials 2–98°; 3–96; 5–92°; 6–88°.

Atelecrinus helgae: Brachials 2–64°; 4–67°; 5–72°; 6–67°.

Metacrinus nobilis tenuis: IBr$_2$–82°; IBr$_3$–90°; IIBr$_1$–90°; IIBr$_2$–82°; IIBr$_4$–80°; IIBr$_5$–88°; IIBr$_6$–84°; IIIBr$_1$–98°; IIIBr$_2$–91°; IIIBr$_4$–85°; IIIBr$_{5-12}$–about 90°; IVBr$_1$–102°; IVBr$_2$–99°; IVBr$_{4-10}$–about 90°; brachials 1–93°; 2–98°; 4 and following about 90°.

Gislén said that from the preceding figures, which might have been supplemented with others from about 40 additional specimens examined but not tabulated, all of which point in the same direction, we learn the following: The first two brachials following an axillary always have a relatively long outer and short inner side. The distal articular line of these brachials therefore makes a relatively large angle with the proximal. The arms, which following the arm division would diverge widely, are thus brought closer together, which because of the limited space is of considerable importance. In reality the length of the outer sides of these brachials is so much greater than that of the inner sides that the distal articular line of the second brachial slopes inward.

In *Metacrinus* the proximal and distal margins of the brachials after the first or second postaxillary are fairly parallel, but in the other types examined a more or less pronounced obliqueness usually sets in sooner or later. In the first syzygial pair (composed usually of brachials $3+4$) this obliqueness is generally only slight—the greater length of the inner side in this pair has counterbalanced almost completely the inward slope that was apparent on the distal margin of the second brachials. The distal edge of the fourth brachial is therefore very often nearly at a right angle to the longitudinal axis of the arm. Subsequently there usually follow a greater or lesser number of brachials in which the proximal and distal edges show a tendency to be more or less parallel, then the obliqueness increases again after the seventh–thirteenth brachial, reaching its maximum at from the fifteenth to the twentieth brachials. In the middle portion of the arms the obliqueness decreases, but it increases slightly again in the distal portion.

THE REVERSION PHENOMENON

This exterior obliqueness manifests itself by the acute angle formed by the articular line with the longitudinal axis of the arm, facing now outward and now inward. The brachials are therefore longer alternately on the outer and inner sides. Usually the pinnule is attached to the longer side of the brachial; this is always the case in the middle and distal portions of the arms. In the proximal portion of the arms Gislén pointed out that the opposite is often found—the pinnules arise from the shorter side of the brachials. He called this reversion of the articulations.

This feature is lacking, or is very little developed, in certain Comasteridae, *Eudiocrinus*, Calometridae, and *Atelecrinus*, in which the pinnular side of the brachials is the longer along the entire arm. Reversion is most conspicuously developed in the Antedonidae and Charitometridae. The second, and usually also the fourth, brachials, bearing P_1 and P_a are more strongly developed on the pinnular side, but from the fifth brachial onward reversion appears in a variable number of segments, to be gradually effaced and followed in the middle of the arm by the normal condition.

Reversion is only slight in *Capillaster sentosa, Comanthus japonica, Tropiometra afra macrodiscus,* and *Pterometra trichopoda,* in which the fifth brachial is only very slightly, sometimes not perceptibly, narrower on the pinnular side, and the sixth brachial has parallel ends, or an obviously longer pinnular side. The same is the case in *Notocrinus virilis,* in which the sixth or seventh brachial has a longer pinnular side, and in *Clarkometra elegans* and *Stephanometra spicata* in which the seventh or eighth brachial is longer on the pinnular side. The reversion appears more distinctly in *Comantheria delicata grandis,* in which the seventh brachial has a longer pinnular side, in *Stenometra diadema, Cyllometra manca,* and *Himerometra magnipinna,* in which the seventh or eighth brachials have longer pinnular sides, in *Zygometra elegans, Heterometra crenulata,* and *Asterometra anthus,* in which the seventh–ninth brachials have longer pinnular sides, and in *Liparometra grandis,* in which the eleventh brachial first shows a longer pinnular side.

This phenomenon appears most conspicuously, however, in *Pentametrocrinus diomedeae,* in which brachials 4+5 have a longer pinnular side, in *Isometra vivipara* and *Hypalometra defecta* in which the eighth brachial, in *Crossometra septentrionalis* and *Antedon petasus,* in which the seventh–ninth brachials, in *Diodontometra bocki,* in which the tenth–twelfth brachials, in *Heliometra glacialis,* in which the twelfth brachial, and in *Promachocrinus kerguelensis* and *Monachometra* cf. *fragilis,* in which the thirteenth brachial first has the pinnular side longer.

Gislén said one might suppose that the slenderness of the pinnule bases had something to do with this phenomenon, and this idea seems to be favored by the Calometridae, *Pectinometra flavopurpurea* and *Neometra multicolor* having the pinnular side of the brachials longer from the arm base outward. But the lack of reversion in *Comatula solaris, Comanthus parvicirra,* and *Atelecrinus* cannot, however, be explained in this way. The two first have slender pinnules, and in the last pinnules are entirely lacking in the proximal portion of the arm.

OBLIQUITY OF THE JOINT FACES, OR INTERIOR OBLIQUENESS

In order to determine the degree of obliqueness in the angle between the transverse ridge and the radial intermuscular fossa (the dorsoventral axis of the ossicle), Gislén measured the angle between them in series of brachials from the arm bases to more distal portions of the arms. The angle measured was always that of the antipinnular side, and unless otherwise stated was on the distal articular facet.

Comanthus japonica: IIBr$_2$, 75–76°; IIIBr$_2$, 68–72°; brachials 2, 60°; 4, 52°; 5, 47°; 6, 57°; 7, 58°; 8, 83°; 9, 87°; 11, 85°; 12, 85°; 13, 86°; 14, 89°; 16, 87°; 17, 87°; 18, 82°; 19, 86°; 20, 86°; 22, 81°; 23, 82°; 24, 81°; 25, 83°; 27, 78°; 28, 82°; 29, 76°; 30, 80°; 31, 81°; distal brachials, 60–76°.

Eudiocrinus indivisus: IBr$_2$, 75°; brachials 2, 64°; 4, 54°; 5, 56°; 6, 47°; 7, 60°; 9, 69°; 10, 78°; 11, 80°; 12, 82°; 13, 86°; 14, 87°. The arm was regenerated from the tenth brachial.

Pontiometra andersoni: An arm arising from a VBr axillary: Brachial 2, 66° or 67°: An arm arising from a IVBr axillary: Brachials 4, 62–67°; 5, 61°; 6, 66°; 7, 62°; 8, 68°; 9, 67°; 10, 68°; 11, 72°; 12, 77°; 13, 78°; 14, 80°; 15, 81°; 16, 84°. From another series, probably beginning with the ninth brachial: Brachials 9, 69°; 10, 72°; 11, 74°; 12, 84°; 13, 86°; 14, 83°; 15, 84°; 16, 87°; 17, 87°; 18, 90°; 19, 85°; 20, 87°.

Pectinometra flavopurpurea: Brachials 2, 86°; 4, 72°; 5, 80°; 6, 63°; 7, 72°; 8, 78°; 9, 75°; 10, 88°; 11, 85°; 12, 90°; 14, 90°; 15, 97°; 16, 91°; 17, 90°; 18, 93°; 19, 90°; 21, 92°; 22, 91°; 23, 86°; 24, 86°; 25, 87°.

Asterometra anthus: Brachials 2, 81–85°; 4, 61°; 5, 64°; 6, 65°; 7, 63°; 8, 74°; 10, 86°; 11, 88°; 12, 80°; 13, 82°.

Clarkometra elegans: Brachials 2, 79°, 80°, 80°, 83°, 84°; 4, 67°, 69°, 70°; 5, 65°; 6, 57–61°; 8, 80°; 10, 82°.

Antedon petasus: Brachials 2, 71°; 4, 68°; 5, 62°; 6, 65°; 8, 71°; 10, 79°; 11, 81°; 12, 82°; 13, 85°; 15, 86°; 16, 87°; 17, 86°; distal brachials about 80°.

Heliometra glacialis: Brachials 2, 71°; 4, 67°; 5, 64°; 6, 64°; 7, 60°; 8, 67°; 10, 65°; 11, 70°; 12, 75°; 13, 83°; 15, 78°; 16, 87°; 17, 79°; 19, 92°; 20, 84°; 21, 86°; 23, 85°; 24, 88°; 25, 85°; 27, 90°; 28, 84°; 29, 89°; 31, 86°; 32, 83°; 33, 84°; 34, 86°; 36, 87°; distal brachials 70–80°.

Thaumatocrinus jungerseni: Brachials 2, 76°; 3, 72°; 5, 66°; 6, 64°; 8, 69°; 10, 75°; 12, 74°; 13, 85°; 14, 80°; 15, 83°; 17, 86°.

Pentametrocrinus diomedeae: Brachials 2, 62°; 3, 60°; 5, 65°; 6, 62°; 7, 65°; 8, 70°; 10, 72°; 11, 75°; 12, 75°; 13, 82°.

Atelecrinus helgae: Brachials 2, 80°, 83°; 4, 87°; 5, 85°; 6, 89°.

Ilycrinus carpenterii: Brachials 2, 82°; 3, 86°; 5, 89°; 6, 90°; 8, 90°; 9, 89°; 11, 92°; 13, 99°; 15, 90°; 17, 92°; pinnules are developed from the eleventh brachial onward.

Rhizocrinus lofotensis: Brachials 2, 90°; 4, 90°; 6, 90°; 8, 84°; pinnules are developed from the eighth brachial onward.

Metacrinus nobilis tenuis: IBr$_2$, 84°; IBr$_3$, 75°; IIBr$_1$, 75°; IIBr$_2$, 72°; IIBr$_4$, 73°; IIBr$_5$, 74°; IIBr$_6$, 74°; IIIBr$_1$, 69°; IIIBr$_2$, 77°; IIIBr$_4$, 74°; IIIBr$_5$, 74°; IIIBr$_6$, 70°; IIIBr$_7$, 71°; IIIBr$_8$, 72°; IIIBr$_9$, 72°; IIIBr$_{10}$, 79°; IVBr$_1$, 71°; IVBr$_2$, 75°; IVBr$_4$, 72°; $IVBr_5$, 69°; $IVBr_6$, 70°; $IVBr_7$, 64°; $IVBr_8$, 69°; $IVBr_9$, 69°; $IVBr_{10}$, 76°; brachials 1, 75°; 2, 73°; 4, 80°; 5, 72°; 6, 73°; 7, 69°; distal brachials, 72–75°.

From these figures it is evident that as a rule obliquity of the muscular articulations is most strongly pronounced immediately following the axillaries, and that the more distal articulations become less oblique, and later in the distal portions of the arms, again somewhat more oblique. An exception to this is found in *Ilycrinus carpenterii* in which the distal angle of the axillary (as viewed dorsally) is very large. Here the proximal brachials, which also lack pinnules, are only slightly oblique, whether viewed from the dorsal side or from the articular face.

As a rule—in the comatulids practically without exception judging from 20 specimens examined in addition to those listed above and agreeing with them—the oblique muscular articulations show the following sequence: After the first brachial articulations at the base of the arm they tend toward the straight type. Gislén's figures of the twenty-seventh brachial of *Heliometra glacialis* and of the thirteenth brachial of *Heterometra crenulata* show how close the oblique muscular articulation on certain proximal brachials can come to the articulation on the radial articular face. This straight type, according to Gislén, occurs more or less completely developed after a varying number of brachials. It should be noted, however, that discoidal brachials, that is, brachials with externally straight articular lines, appear before the tenth brachial whereas the interior straightness of the articulations does not generally appear until after the tenth or fifteenth brachial. These two types are therefore usually separate, and seldom appear on the same brachial.

Gislén remarked that *Clarkometra elegans* shows, for an antedonid [I consider it a colobometrid], a rather high figure for the angle on the second brachial. He supposed that one might imagine this to be caused by the lack of pinnules; but the fourth brachial, which is also nonpinnulate, shows a normal figure.

That inner obliqueness can be extraordinarily strong is shown by *Pentametrocrinus,* in which the first pinnule appears on the fifth brachial. The species of *Atelecrinus* lack pinnules to about the fifteenth brachial. In spite of this, external obliqueness is well developed. Inner obliqueness, on the other hand, is very little marked, and straight articulations are met with already at about the sixth brachial.

Gislén inferred one can understand from this that in the comatulids the presence or absence of pinnules plays a rather small part in regard to external obliqueness in the proximal portion of the arms. It is of more importance in regard to inner obliqueness, although it is obvious that in the more proximal parts of the arms other factors appear that influence the obliqueness of the muscular articulations. The low figures of the angles in *Eudiocrinus* may be caused by the fairly thick pinnule bases.

If the morphological reasons for the oblique angle between the intermuscular fossa and the transverse ridge are studied the following facts appear: The difference in size between the two muscular fossae is usually of less importance; the difference in size between the interarticular ligament of the pinnular side and that of the antipinnular side is, however, often much greater. This difference reaches its maximum in the antedonids. Through the interaction of muscle, pinnule socket, and interarticular ligament the pinnular side of the distal facet of the segment is enlarged ventral to the transverse ridge, and as a result the dorsoventral intermuscular furrow looks as if it were forced over toward the antipinnular side. In reality, however, this is not entirely so. If one studies the ventral side of an arm from which all the soft parts excepting the ligaments have been removed, one will find that the intermuscular furrow or crest is always oriented strictly dorsoventrally. It is therefore more correct to express the inner obliqueness of the articulation by saying that muscle, pinnule socket, and interarticular ligament displace the transverse ridge toward the dorsal side of the segment, or the pinnular side of the distal end of the ossicle—or the antipinnular side if the ossicle is observed from the proximal end.

Gislén examined the distal articular faces of the axillaries to determine whether they should be interpreted some as straight and others as oblique, or as intermediate between the two types. The following figures were obtained by measuring the distal axillary angles (the lesser angle between the transverse ridge and the dorsoventral crest).

Comanthus japonica: (IBr$_1$ proximal 87°; IIBr$_1$ proximal 78°); IIBr axillary 67–70°; IIIBr axillary 60°.

Himerometra magnipinna: IIBr axillary 50°; IIIBr axillary 63°.

Pontiometra andersoni: IBr axillary 87°; IIIBr axillary 82–85°; IVBr axillary 78–82°; VBr axillary 80°.

Tropiometra afra macrodiscus: IBr axillary 80°.

Cenometra bella: IIIBr axillary 76°.

Oligometrides adeonae: IBr axillary 77°.

Pectinometra flavopurpurea: IBr and IIBr axillaries 90°.

Asterometra anthus: IBr axillary 87°.

Notocrinus virilis: IBr axillary 87°.

Clarkometra elegans: IBr axillary 84°, 84°, 85°, 89°.

Heliometra glacialis: IBr axillary 86°.

Ilycrinus carpenterii: IBr axillary 74°.

Metacrinus nobilis tenuis: Radials 89°; IBr axillaries (4) 70°; IIBr axillaries (7) 63°; IIIBr axillaries (11) 67°; IVBr axillaries (11) 68°.

From this it appears that *Comanthus, Himerometra,* (*Pontiometra*), *Tropiometra, Cenometra, Oligometrides, Ilycrinus,* and *Metacrinus* have oblique articulations, while the other types examined have nearly straight articulations.

It is evident from these figures, according to Gislén, that no sharply defined boundary can be found between straight and oblique muscular articulations.

Gislén said that if one accepts the later of the standpoints taken by the author one should be able to maintain that the straight muscular articulation on the distal face of the radial is always single, while all the other ossicles with muscular articulations have double articular faces, that is, form axillaries or bear an arm and a pinnule on their distal ends—though in this connection one must remember that there are types with defective pinnulation. In such a case Z$_1$ and Z$_2$ would always correspond to the first two brachials which might also, with a certain degree of justice, be called homologous in the recent crinoids. Gislén concluded it can be stated that the homologization of certain proximal brachials based upon a supposed distinct difference between straight and oblique muscular articulations is erroneous.

Gislén noted that the arm divisions are brought closer together by the first two brachials being longer on the outer side of the arm than on the inner. This is of some importance, for after the first arm division the arms in 5-rayed forms cannot, if they are to expand in the same plane, diverge at an angle greater than about 72°. As a consequence of this the distal angle of the axillary ought not to be less than 108°. It turned out, however, that among the forms examined *Ilycrinus carpenterii* and *Monachometra* cf. *fragilis* only have an angle rising to any great extent above this figure. In these two cases it reaches 162° and 145°, respectively. All the other types except two have a IBr axillary angle of less than 108°—*Comanthus japonica* 88°; *Capillaster sentosa*, 105°; *Amphimetra tessellata*, 106°; *Pontiometra andersoni*, 105°; *Tropiometra afra macrodiscus*, 105°; *Pectinometra flavopurpurea*, 104°; *Diodontometra bocki* and *Asterometra anthus*, 110°; *Notocrinus virilis*, 83°; *Clarkometra elegans*, 103°; *Hypalometra defecta*, 96°; *Antedon petasus*, 78°; *Heliometra glacialis*, 68–72°; *Atelecrinus helgae*, 81°; and *Metacrinus nobilis tenuis*, 98°. In the 10-rayed *Promachocrinus kerguelensis* the IBr axillary ought not to fall below 144°; but in reality it is 107° here.

Axillaries of higher rank, assuming the highest possible number of arms allowed by the full number of the division series, would have angles as follows: IIBr axillary, 144°+; IIIBr axillary, 162°+; IVBr axillary, 171°+. The types examined, however, gave the following figures: *Comanthus japonica*, IIBr axillary, 104°, IIIBr axillary, 104°; *Capillaster sentosa*, IIBr axillary, 126°; IIIBr axillary, 120°; IVBr axillary, 131°, VBr axillary, 120°; *Pontiometra andersoni*, IIBr axillary, 130°, IIIBr axillary, 130°, IVBr axillary, 115°; VBr axillary, 105°; *Pectinometra flavopurpurea*, IIBr axillary, 126°; *Metacrinus nobilis tenuis*, IIBr axillary, 104°, IIIBr axillary, 102°, IVBr axillary, 108°.

All the examples given above, other than the exceptions mentioned, have their arms diverging far too rapidly. But owing to the first postaxillary ossicles being longer on the outer side of the arms than on the inner this is counterbalanced. If the arms were narrow proximally and not in lateral contact, the basal portions of the free arms could certainly diverge at angles greater than those theoretically possible. In such a case, however, the divergence must soon be lessened to prevent the arms interfering in the more distal portions.

If the distal angle of an axillary is smaller than the theoretically possible angle, the sides of the brachials immediately following, in order to restore the arms to the requisite angle, must be longer on the outside of the arms than on the inner side, and the angle that the proximal and distal ends form with each other must reach at least the difference between the actual distal angle of the axillary and the minimum possible. It seems, however, to be a general rule that the divergence of the arms is still further diminished, so that they become nearly parallel with each other. The earliest brachials are usually so much longer on the outside than on the inner side that the distal end of the first brachial forms almost a right angle with the longitudinal axis of the preceding axillary, and the distal end of the second brachial slopes somewhat downward and inward. The too strong convergence of the arms resulting from this is compensated by the first syzygial pair (composed of brachials 3+4) being longer on the inner side of the arm than on the outer, so that the distal margin of the epizygal (fourth brachial) is almost at right angles with the longitudinal axis of the arm. The effect of the arm branching on the obliqueness of the brachials is thus counteracted.

The conditions found in *Clarkometra* and in *Hypalometra* show that the presence or absence of P_1 and P_a has no influence worth mentioning upon the obliqueness of the first four brachials.

In the comatulid brachials special cases sometimes occur in which the greater length of the pinnular side is pronounced from the beginning; more often, however, a series of discoidal segments follows the fourth brachial, or the reversion phenomenon occurs.

INFLUENCE OF THE PINNULATION ON THE OBLIQUENESS OF THE BRACHIALS

In the distal portions of the arms the position of the pinnules evidently has a controlling influence upon both the outer and the inner obliqueness of the brachials. The pinnular side of the brachial becomes more strongly developed; this causes its outer obliqueness. The pinnule's point of insertion enlarges the pinnular side of the articular face; this causes its inner obliqueness.

As examples of the decisive rôle that the position of the pinnules plays in regard to obliqueness Gislén mentioned a specimen of *Pectinometra flavopurpurea* in which pinnules appear on the right side of both the ninth and tenth brachials, the proximal and distal borders of the tenth brachial being, as a result, parallel; and a specimen of *Heliometra glacialis* in which on one arm the ninety-second brachial bears two pinnules of normal size (19–20 mm. long) and has the distal articular face perfectly symmetrical and lying in a plane perpendicular to the longitudinal axis of the arm.

Gislén remarked that in certain cases it seems as if the idea that phylogenetic causes may have played a certain part in bringing about obliqueness cannot altogether be dismissed. Thus in *Atelecrinus*, which lacks pinnules as far out as the twelfth or fifteenth brachials, if the arm division and pinnulation were the only causal factors, it might be expected that straight articulations would be found between at least the fourth and twelfth brachials. This seems to be the case regarding interior, though not exterior, obliqueness. The side of the brachial that would have borne the pinnule, if a pinnule were present, is in fact always longer than the opposite side. It is presumable that phylogeny must be invoked here in order to explain the exterior obliqueness of the brachials. The lateral flexibility, except at the synarthrial articulation, here seems to be extremely slight, so that there is no trace of reversion in this case.

On the proximal brachials the pinnule socket always more or less invades the articular face, either intruding between the muscular and interarticular ligament fossae, or lying ventral to the muscular fossae. On more distal brachials the pinnule socket may wander out on to the lateral portion of the brachial so that is it completely isolated from the articular face of the brachial, or it may lie on the ventral side of the brachial and therefore, as in the proximal portion of the arm, ventral to the muscular fossa. In the former case the brachials are more or less elongated with markedly oblique articulations, while in the latter the brachials are usually short and discoidal. Here, however, the size of the pinnule base plays a certain rôle. On account of the insertion of the pinnule bases the Calometridae ought to be placed in the latter group. However, the extraordinarily stout proximal pinnule segments do not permit such a pronounced shortening of the brachials as is seen in the Mariametridae and Himerometridae. In the Calometridae the pinnule attachment is extended at the expense of the muscular fossa of the pinnular side, which is reduced and acquires a more horizontal position on the distal side of the articular face.

In other cases where the pinnule has a ventral origin the shortening of the brachials (ontogenetically as well as phylogenetically) may lead to discoidal brachials on which the proximal and distal articular faces are parallel. If, on the other hand, the origin of the pinnule is more lateral, then with the shortening of the brachial, the pinnule being of normal size, a tendency toward greater shortening of the antipinnular side may make itself felt, and a certain inclination to dichostichality or biseriality appears in the arms. Among recent forms this is strongly pronounced in certain Comasteridae, in which there may be observed a thickening of the arm bases and at the same time a relative shortening of the brachials. This tendency toward biseriality is very evident, for example, in *Comatula pectinata,* but is best developed in *Comatulella brachiolata.*

Gislén said it might be imagined that the thickening of the arms has been stimulated by two causes. First, in these types the gonads are developed in the arms; but this circumstance can scarcely play any very large part since in various other recent crinoids (*Metacrinus, Notocrinus,* and *Isometra*) gonads in the same position do not induce any thickening of the arms. Second, one may refer to the role that the creeping motions typical of the Comasteridae undoubtedly play.

THE ACTIVE FLEXING POWER OF THE LIGAMENTS

In the interbrachial articulations the transverse ridge serves as a hinge or fulcrum. On each side of this ridge are ligaments that are about equally powerful—the interarticular ligaments and the dorsal ligament. Gislén remarked that if the dorsal ligament were antagonistic to the muscles alone it would be difficult to understand of what service the interarticular ligaments could be. Possibly it might be imagined that with the relaxation of the muscles they serve to counteract a too hasty flexion of the arms dorsally, which might involve the risk of breakage. It might also be supposed that with the ventral flexion of the arms the interarticular ligaments become compressed so that when the muscles are relaxed they would supplement the action of the dorsal ligament. Both these suppositions are confuted, however, by the fact that when the muscles are cut through no very strong dorsal bending of the arms occurs. A little dorsal flexion often appears which, however, is soon effaced. Another circumstance speaking in favor of the ligament's capacity for motion is the fact that the two ligament bundles of the synarthries may sometimes be rather unequally contracted, thus giving the arm or arm pair an oblique position. From this Gislén believes that the ligaments play a certain active part in the flexions of the arm.

Gislén said that the arms of stalked crinoids seem to move quite slowly in comparison with those of recent comatulids according to Bock's observations on living *Metacrinus* and his own observations on *Rhizocrinus.* It should be noticed, too, that the ligaments between the proximal cirrus segments in the pentacrinites are very strongly developed so that even a slight contraction gives a powerful effect in the distal part of the very long cirrus.

DEVELOPMENT OF THE LIGAMENTARY ELEMENTS AMONG CREEPING TYPES

The Oligophreata in general and the comasterids in particular have only inconsiderable muscular attachments in comparison with their ligamentary interarticular connections. In certain comasterids the proximal portion of the arms is greatly thickened, and this thickening, so far as regards the calcareous ossicle itself, is caused by the specially strong development of the ligamentary connections.

Gislén pointed out that for a swimming type, like *Antedon,* a very important condition is that the structure of the arms should be light and slender. For creeping types, on the other hand, a stout and solid structure is of less consequence, if only the levers are powerfully built. It is therefore difficult to avoid the supposition that the thickness of the arm bases bears a certain relation to the creeping habits of the comasterids. As the ligament fibers are much more intimately connected with the calcareous mass of the ossicle than are the muscle bundles, as the muscles in these types are rather poorly developed, and as it must be presumed that the ligamentary elements possess a capacity for active motion, Gislén sees no objection to accepting the hypothesis that an arm of the type mentioned must answer better the demand for an efficient pull and push lever than is the case with the more graceful and delicate arms found in the other comatulids that are better adapted for swimming.

Gislén noted that a large number of the oldest (Jurassic) comatulids also had very stout arm bases that were often thickened proximally, where the same tendency to biseriality seen in *Comatulella* and *Comatula* appeared, although often it went much farther. Here, too, the muscular attachments, as in all the older Articulata, are weakly developed in comparison with the ligamentous connections. Gislén said that one can not help thinking that these phylogenetically old comatulids, which had fairly recently given up their sedentary habits, had not yet gained any great capacity for swimming, but were chiefly creeping types. On the other hand the antedonids, which are good swimmers, would then be a later type, more suited for a free and active mode of existence.

SOLUTION OF THE REVERSION PROBLEM

The causes of the shortening of the pinnule-bearing side of the proximal brachials in certain comatulids according to Gislén are the following:

The degree of the effect caused by an articulation's capacity for flexing the arm as a whole both ventrally and laterally increases as the position of the articulation becomes more proximal. The greatest capacity for flexion must therefore be considered to exist in the most proximal brachial articulations. In the proximal articulations the interarticular ligament on the distal articular face of the brachials is developed much more strongly on the pinnular side than on the antipinnular side. As a result of the encroachment of the pinnule socket, which is fairly large in the proximal portion of the arms, the interarticular ligament of the pinnular side, and also the transverse ridge, is displaced dorsally on the pinnular side of the brachial's distal articular face. On the proximal articular face of the succeeding brachials it is the end of the transverse ridge on the antipinnular side of the brachial that is displaced dorsally. In other words, we find in the dorsal part of the articulation a certain likeness to a synarthry, although a very oblique one. The dorsal end of the transverse ridge, which runs between the great interarticular ligament and the dorsal ligament, is now produced so that a process from the proximal margin of the more distal brachial fits into a notch in the distal margin on the more proximal brachial. We thus get something very similar to an oblique synarthrial projection where, as in the latter, the synarthrial process is directed backward. At the same time as this prolongation of the proximal margin of the distal brachial takes place posteriorly, the point of attachment for the great interarticular ligament spreads out on the lateral inner side of the increased attachment surface. As the projection from the more distal ossicle fits into the more proximal ossicle on its pinnular side, it encroaches upon the breadth of the pinnular side of this brachial, which thus becomes narrower than the antipinnular side. On the other hand, the more distal brachial, which bears the process, is strengthened on the antipinnular proximal side by the posteriorly directed process, and thus becomes broader there.

It is evident that such a structure gives the arm increased capacity for flexion laterally. An articulation in which both the end points of the transverse ridge are strictly lateral evidently would not permit of any flexion at all laterally, whether the articulation in other respects is oblique or not.

The greater this reversion of the conditions of breadth in the proximal brachials, the greater the capacity for lateral flexion in the arms. A certain amount of lateral flexion is possible in all arms in which synarthries are developed. In fossil types where synarthries are found and in recent stalked crinoids this restricted possibility for lateral motion seems to be adequate. The same seems to be the case in the primitively organized *Atelecrinus* in which no decrease at all of the breadth of the pinnular side of the brachials appears in any part of the arms. Here one is able, from the primitiveness of the type in other respects, to assume an inconsiderable lateral mobility. An increased lateral mobility here would, according to Gislén, most likely give rise to discoidal brachials.

Under certain conditions a case apparently similar to that of *Atelecrinus* may occur because of enormously enlarged pinnule bases, as for instance in the Calometridae. In other cases the habit of creeping, as in a number of genera of Comasteridae, possibly combined with original primitiveness, may bring about a similar phenomenon.

In all the other comatulids reversion may be observed. In the cases in which it is little developed the influence of the pinnule is about equal in importance to the counteracting, reversional, lateral flexibility; here we get in the proximal portion of the arms a number of discoidal brachials. In the cases in which it is more strongly developed, as for instance in the Antedonidae, the capacity for lateral flexion is the strongest, and a number of brachials appear which are considerably narrower on the antipinnular than on the pinnular side.

THE MUSCLES

Gislén's conclusions in regard to the origin and development of the musculature in the crinoids are as follows: A pair of longitudinal muscle bands, corresponding to those in the holothurians, presumably existed on the ventral side of the arms of the oldest crinoids. With the demand for increased and more rapid motion of the arms these muscle bands began to play a more active part in flexing the arms, and therefore acquired stronger attachments to the brachials. The brachials developed crests and calcareous processes, and these extended outward into the longitudinal muscle band and divided it into segments, which now correspond to the interbrachial muscles.

For the only slightly movable arms of most of the Paleozoic crinoids the ligamentary articulations in the proximal part of the arms, which still lacked true muscles, were sufficient for the flexion required. In these crinoids we therefore find only syzygial, or more commonly more or less synostostical, articulations in the middle and distal portions of the arms. Later, with the necessity for increased speed and effectiveness in movement, the true muscles, which heretofore had only been found in the ventrally situated soft parts, became associated with the calcareous skeleton. This association took place earliest in the articulation between the radials and the arms, standing alone in its type, in the Flexibilia, according to Springer becoming extinct in the upper Carboniferous without leaving any descendants. The Articulata, which according to Gislén may be traced back to *Poteriocrinites*, which in its turn is descended from some group of *Dendrocrinites*, have independently followed a similar course and developed the type usual in recent crinoids. Among the Jurassic comatulids the muscle attachments are still relatively insignificant. In the radial muscular articulations they may sometimes even be lacking, as in *Pontiometra* and *Stephanometra;* but this seems to be a condition of secondary origin.

Gislén said that the ligamentary articulations would thus appear to be the oldest arm flexors, which, through their action, have developed the transverse ridge. Therefore the interarticular ligaments are the original antagonists of the dorsal ligaments. The ligamentary articulations can be derived from the close sutural connections between the ossicles of the Cambrian, Ordovician, and Silurian crinoids. The role of true muscles as arm flexors would be of later date, arising from the necessity for increased and more rapid motion. The muscular articulations first reach their full development in certain recent eleutherozoic comatulids, while other comatulids less suited for swimming, many recent stalked crinoids, and the Permian to Jurassic forms, have muscular attachments that are very modestly developed.

LIGAMENTOUS ARTICULATIONS IN THE ARMS

Gislén divided the articulations lacking striated muscle fibers into immovable and movable ligamentary articulations. The immovable ligamentary articulations he subdivided into (1) *close synostosis* (with a flat smooth joint face, as the junctures between the radials); (2) *syzygy;* (3) *pseudosyzygy;* and (4) *anchylosis.* The movable ligamentary articulations he divided into (1) those movable in all directions, and (2) those movable in one plane only. Those movable in all directions he subdivided into (a) articulations between the columnals of pentacrinites and comparable types, with petaloid sculpture; (b) *loose synostosis*—the apposed joint faces somewhat concave, without scultpure; and (c) *pseudosyzygies* as developed between the calyx plates in the Flexibilia. Those movable in one plane only he divided into (a) *synarthry* (the *cryptosynarthry* being a transition between the synarthry and synostosis); and (b) *ligamentary articulation,* with at least three ligamentary pits (occurring in place of syzygies in the Bathycrinidae, and according to Gislén between the radials and the IBr_1 in *Pontiometra* and *Stephanometra* and perhaps also in burdigalocrinid stems; this is the trifascial articulation of P. H. Carpenter).

The articulations including striated muscle fibers Gislén divided into two categories: (a) those movable dorsoventrally, with one dorsal and two interarticular ligaments and two fairly strong muscle bundles—*muscular articulations, sensu stricto;* these occur between the brachials, between the brachials and first pinnule segments, and between the first two pinnule segments; and (b) those movable in a lateral direction only, with no ligament fossae and usually small muscle fossae—*pinnular articulations;* these occur between the pinnule segments from the second onward in the proximal part of the arms.

Gislén said that of the ligamentary articulations the oldest both ontogenetically and phylogenetically is the synostosis. The synarthry can thus scarcely be derived from the syzygy, or the syzygy from the synarthry; both are differentiated varieties of synostosis, specialized for particular purposes. One or the other form has developed in response to the different demand made by the articulation in question. Sometimes, however, the syzygy seems to develop into the synarthry. In *Crossometra septentrionalis*, in which usually the first two brachials are united by syzygy, Gislén observed in one case two lateral concavities near the nerve lumen. The center of the joint face therefore represents a synarthry, while the peripheral portion is of the normal syzygyial type. *Catoptometra* (*magnifica minor*) shows possibly a somewhat different direction in its development. In fully grown individuals the articulation between the IBr_1 and IBr_2 is syzygial; in the young this articulation is furnished about its periphery with weak syzygial septa with a slightly stronger dorsoventral thickening which gives the joint face a somewhat synarthrial aspect.

Typical syzygies scarcely occur in recent stalked crinoids. *Calamocrinus* and *Ptilocrinus* have typical synostoses, as have a large number of pentacrinites also. In the pentacrinites, however, there is an evident tendency toward the development of syzygies. Here, as in the fossil forms, there is found the first tendency toward the formation of syzygies, foreshadowed by a weak fluting of the dorsolateral margin of the joint face. The marginal ridges gradually extend toward the center, and when they reach it the typical syzygy appears. The species of *Metacrinus* have almost typical synostoses, which, however, sometimes show a very indistinct marginal striation. Syzygies are indicated about as feebly in *Annacrinus.* On the other hand, a syzygial type is rather distinct in *Hypalocrinus naresianus* and in *Cenocrinus asteria.*

In describing the syzygies of the comatulids, Gislén called the thickened margin of the nerve lumen the areola. The radiating ridges he called the septa. They are complete when they reach the areola, or incomplete when they run only part way in from the periphery of the joint face. They are called finished when they arise within the margin of the joint face and continue to the center. They are forked when two fuse a short distance within the margin. When the septa are both incomplete and finished, there result small, low, more or less rounded protuberances—the tubercles. In many of the larger forms the ventral septa especially show a tendency toward division into rows of tubercles. Sometimes concentric ridges—synapticulae—run at certain distances from the nerve lumen. The areola is often connected with the ventral, usually grooveless, part of the joint face by a more or less broad smooth line—a ventral beam. Usually the median portion of this ventral beam is occupied by a pit or furrow, so that there are two parallel ventral beams. These ventral beams may be developed as coarse bow-shaped septa that run out to the margin of the joint face.

These ridges and other elevations as found in different forms are marked by different degrees of sculptural relief. Gislén denoted the strength of relief by figures from 1 to 4. The figure 1 was assigned to forms having the septa only feebly indicated, as for instance certain Charitometridae; syzygies in which the septa stand out in high relief, such as those in *Heliometra glacialis*, are given the figure 4.

The elevations on the distal face of the hypozygal are matched by corresponding elevations on the proximal face of the epizygal. When the syzygial articulation is observed from the dorsal side of the arms it is seen as a dotted line, the dots marking the ends of the canals between the septa which are traversed by the ligaments.

Gislén noted that the development from synostosis to syzygy evident in the phylogenetic history of the crinoids appears again in the ontogeny of the comatulids. In the comatulids very young individuals have the ligamentary connections in the form of synostoses. The distal face of the hypozygal is somewhat concave, and the proximal end of the epizygal somewhat convex. The change from synostosis to another form of ligamentary union seems to take the following course. The synostosis becomes less close—in other words, the ligamentous fibers between the ossicles in certain places become longer. Sometimes the contact is retained about the lumen, resulting in an areola, and the contact seems to be closer at the margin of the ossicles. If the articulation is to develop into a synarthry, a strong areola always appears from which a ventral and dorsal beam grow out, resulting in the dorsoventral articular ridge. But if the articulation is to develop into a syzygy an areola may appear and persist, or it may be altogether lacking. The septa, very feeble at first, appear in the dorsal and lateral parts of the joint faces and are extended outward, because with the appositional increase of growth in the articulation they continue in contact with the margin. During the development the septa increase in number, and the new ones that are formed later arise in the same way from the border of the joint face, intercalated between the septa first formed, which extend into the neighborhood of the central lumen. That the septa must also to some extent increase in growth toward the center is seen by the increasing number of complete septa in older invididuals. It is certainly true that the lumen is somewhat enlarged during growth, but this is not sufficient to explain the increase of complete septa. In a young *Antedon petasus* the diameter of the ossicle is 0.31 mm., and of the central lumen 0.06 mm. There are two complete septa. In a full grown individual the lumen is 0.19 mm. in diameter, and there are 12 complete septa.

The variation in the number of septa in any given species at any given age is rather small and unimportant. In a *Mariametra subcarinata*, for example, Gislén found the number of septa on the distal end of four third brachials to be 15–16. In a specimen of *Heliometra glacialis* the number of septa on the distal end of the third brachial was 36–36, and in another of *Promachocrinus kerguelensis* the number was 27–30. The type of syzygy was here, as everywhere else, uniform within the species. In strongly multibrachiate forms the size of the segment and the number of septa may vary a little more, according to whether one examines an inner or an outer arm, and the number of axillaries preceding the arm, as for instance in *Capillaster*, *Comantheria*, and *Stylometra*. Beyond the first syzygy the number of septa in a few syzygies may increase slightly, but fairly soon the septa decrease in number, as a natural result of the distal portion of the arms being younger and slenderer than the proximal. The ninety-first brachial (about the thirtieth hypozygal) in a fully grown *Heliometra glacialis* with arms about 200 mm. long had only 22 septa, consisting of 7 ventral rows of tubercles and 15 more or less incomplete septa. The hypozygal following had the same number of septa. In the small *Isometra vivipara* with arms about 60 mm. long the distal face of the third brachial had 14 septa. In this specimen the fourth or fifth syzygyial articulation was developed as a synostosis, although not a close one, and lacked septa.

Large and stout types have usually an unusually large number of septa for the systematic units to which they belong, while small and more delicate forms have an unusually low number. Also young and immature individuals have fewer septa than fully grown individuals of the same species. A young *Heliometra glacialis* from

Taimyr with arms about 18 mm. long had in two cases 18 septa on the end of the third brachial; on the ninth brachial there were 18 and on the fourteenth 15 septa. Another young individual of the same species from East Greenland with arms 65 mm. and cirri 18 mm. long had on the distal end of the third brachial 20 septa. A young individual of *Catoptometra magnifica minor* with arms 35 mm. long had 11 septa on the distal end of the IBr_1, two of them complete and forming an indistinct dorsoventral ridge. On the distal face of the third brachial there were 16 septa, 6 complete septa and 2 ventral beams. The degree of strength was 1. No areola was present. On the distal face of the ninth brachial there were 14 septa, and on the distal face of the fourteenth brachial 12. A full-grown *Catoptometra rubroflava* with arms about 100 mm. long had 28 septa on the IBr_1, 25 on the third brachial, and 24 on the ninth brachial. A young *Antedon petasus* with the arms about 16 mm. long had two (complete) very weak septa, visible only with the strongest magnification.

COMASTERIDAE

Comatella brachycirra.—In a specimen with the arms about 50 mm. long the distal face of the third brachial has 15 septa, 5 complete broad septa and 2 ventral beams; the degree of strength of the septa is 3. In another case there were 17 septa on the distal face of the third brachial, and 13 on the distal face of the sixteenth brachial.

Comissia peregrina magnifica.—In a specimen with arms about 150 mm. long the distal face of the third brachial has 30 septa, 11 complete septa, one of them forked, 16 incomplete septa, and 2 ventral beams. The degree of strength is 4. The areola is of medium breadth, stout and well marked. The distal end of the thirteenth brachial has 27 septa, 13 incomplete septa and 3 ventral rows of tubercles. The septa run out into the dorsal margin of the ossicle.

Capillaster sentosa.—In a specimen with the arms 90 mm. long the $IIBr_2$ has 45 septa, 6 complete septa and 2 ventral beams. The $IIIBr_2$ has 44 septa, 8 complete septa, 2 ventral beams, some septa forked, a distinct areola, strength 4. In three other cases the septa are 44, 43, and 42. The $IVBr_2$ has 37, 38, 39, and 43 septa. The VBr_2 has 33 and 38 septa. The second brachial, following a VBr axillary, has 28 and 25 septa, 2 complete. In a fifth case the number of septa on a $IVBr_2$ is 44, 2 of them ventral beams. On the following second brachial the septa were 40, two of them complete; there was a narrow but distinct areola; the degree of strength was 3. In another case the second and third brachials would not separate in spite of violent boiling in KOH. On the twenty-ninth brachial (second hypozygal) there were 34 septa, 3 complete septa, 6–7 very small tubercle-shaped marginal septa, and 2 ventral beams; the degree of strength was 4. In another case the second hypozygal (about the thirty-first brachial) had 29 septa.

Comatula pectinata.—In a specimen with the arms about 70 mm. long the proximal face of the axillary had 58 septa with the degree of strength 3–4; of the septa 45 are dorsally or laterally directed; the 13 septa directed ventrally are incomplete; of the 45 dorsal septa 19 are complete and some are forked; the areola is indistinct; the surface of the ossicle is not, as usual, even or evenly curved, but is divided into three or four faces that stand somewhat obliquely to one another and on different levels in the horizontal plane when the ossicle is viewed from the proximal end; Gislén says it recalls the metacarpal III of a horse; the 58 septa run over these faces. On the distal end of the first brachial there are 42 septa, 34 dorsally and 8 ventrally directed; 15 are complete. In another case there are 43 septa, of which 4 are rows of tubercles. On the distal end of the third brachial in two cases there are 39 and 40 septa. On the eighth brachial there are 42 septa, on the fifteenth 43, on the twentieth 44, of which 10 are complete. The areola is narrower than in the preceding species. The septa are distinct, but broad and rather low.

Comantheria delicata grandis.—In a specimen with the arms about 110 mm. long the third brachial has 34 septa, with 6 ventral rows of tubercles, the degree of strength being 3. In another case there are 37 septa. The areola is broad, but low and rather indistinct.

Comaster serrata.—In a specimen with the arms about 60 mm. long the articulation in the IBr series is a pseudosyzygy; the areola is rather broad with 5 finished tubercular septa and in addition two concentric rings of tubercles; the degree of strength is 3. The distal face of the third brachial has 19 septa, broad and low, of which 10 are complete. The areola is narrow.

Comantheria grandicalyx.—In a specimen with the arms about 120 mm. long the $IVBr_3$ has about 31 septa with the strength 4. All the septa are incomplete, not reaching the stout areola. Between the areola and the inner ends of the septa there is a ring of 8 or 9 tubercles. There is a stout ventral beam and also a similar short finished one. A third brachial on the outer side of a division series has 31 incomplete septa, and an inner ring of 11 tubercles, with a distinct synapticle ring dorsally. The ventral beam is rather indistinct; the areola is stout. In another third brachial on the outer side of a division series there are 29 septa, three of them complete. The ring of tubercles is developed on one side only, and includes 6 tubercles. The ventral beam is stout and lobed. Hypozygals from the distal parts of the arm have 15–17 septa, all incomplete, with the degree of strength 3. The areola is narrow and insignificant.

Comanthus japonica.—In a specimen with the arms about 110 mm. long the $IIBr_3$ has about 44 septa; of these 21 are complete, most of them finished, 18 are incomplete, and there are 5 ventral rows of tubercles. The degree of strength is 4. The areola is stout, well marked, and rather broad. The twenty-sixth brachial (fourth brachial hypozygal) has 35 septa of which 11 are complete. The areola is rather narrow.

ZYGOMETRIDAE

Catoptometra rubroflava.—In a specimen with arms about 100 mm. long the distal end of the IBr_1 has 28 septa, of which 8 are complete; these are broad and rather low, with the strength 3 (—4); the areola is of medium width. The distal end of the third brachial has in one case 25 septa, and in another 23. The ninth brachial has 24 septa.

Zygometra microdiscus elegans.—In a specimen with the arms 105 mm. long the distal end of the $IVBr_3$ has 30 septa, about 13 complete, with the degree of strength 3; the areola is absent.

Eudiocrinidae

Eudiocrinus indivisus.—In a specimen with arms about 70 mm. long the IBr_2 has on the proximal end 16–17 septa. The third brachial has on the distal end 21 septa that are very low, especially toward the center, with the degree of strength 2; the areola is indistinct.

Himerometridae

Himerometra magnipinna.—In a specimen with arms 105 mm. long the $IIIBr_3$ has 35 septa, becoming rather indistinctly marked toward the areola, which is also indistinct and situated in a central concavity; the degree of strength is 2.

Heterometra crenulata.—In a specimen with arms about 95 mm. long the distal end of the third brachial has 41 septa; there are two stout ventral beams and about 7 complete septa; the intervals between the septa are rather narrow; the areola is narrow and rather indistinct; the degree of strength is (2—) 3. The sixteenth brachial (second hypozygal) has 48 septa, of which about 13 are complete; there are two ventral beams. The thirty-first brachial (third hypozygal) has 50 septa.

Mariametridae

Stephanometra spicata.—In a specimen with the arms 135 mm. long the distal end of the third brachial has 31 septa, one complete and two ventral beams, with the degree of strength 3. On another third brachial there are 29 septa, of which 2 are complete; the areola is narrow, but rather distinct.

Liparometra grandis.—In a specimen with arms about 120 mm. long the third brachial has 37 septa, 10 complete and 2 represented by indistinct ventral beams, the degree of strength being 3; the areola is distinct. The ninth brachial has 31 septa.

Lamprometra palmata.—In a specimen with an arm length of 90 mm. the third brachial (following a IVBr axillary) has 24 septa, 6 complete and 2 ventral beams; the areola is distinct and of medium breadth; the degree of strength is 4. In another case there are 23 septa. The twenty-second brachial (second hypozygal) has 22 septa. The thirty-third brachial (third hypozygal) has 24 septa, 5 complete and 2 incomplete ventral beams. The distal syzygies, from about the one hundredth to about the one hundred and tenth brachials, or about the tenth hypozygal, have 16 incomplete septa. The hypozygal following has 14 incomplete septa, with the degree of strength (1—) 2.

Mariametra subcarinata.—In a specimen with arms 60 mm. long the third brachial has 15 septa, including 2 complete septa and one ventral beam, with the degree of strength 4–3. In other cases the septa are 15, 16, 16, with 3, 5, and 6 complete septa. The areola is rather narrow, but usually stout.

Colobometridae

Pontiometra andersoni.—In a specimen with the arms about 160 mm. long the third brachial, following a VBr axillary, has 36 septa, of which 5 are complete and 2 are ventral beams, with the degree of strength 4. In other cases the third brachial, following IVBr and VBr axillaries, has 37, 39, and 39 septa. The areola is stout, well marked, and of medium width.

Cenometra bella.—In a specimen with arms 90 mm. long the third brachial has 21 septa, of which 10 are complete and 2 are indistinct ventral beams, with the degree of strength 3. The thirtieth brachial (second hypozygal) has 19 septa, of which about 6 are complete. Gislén says that this reminds one of the *Liparometra* type.

Cyllometra manca (*"disciformis"*).—In a specimen with an arm length of 90 mm. the third brachial has 16 septa, of which 9 are complete and 2 are ventral beams, with the degree of strength 3; the areola is narrow and rather indistinct. The thirteenth brachial (second hypozygal) has 17 septa, the eighteenth has 14, the twenty-third has 15, the twenty-ninth has 13, and the thirty-fifth (sixth hypozygal) has 13. The areola is lacking. The degree of strength is 1–2.

Oligometrides adeonae.—In a specimen with arms 60 mm. long the third brachial has 30 septa, of which 13 are complete and one is a ventral beam; the areola is indistinct; the degree of strength is 3. The nineteenth brachial (second hypozygal) has 24 septa, of which about 11 are complete; the ventral beam is indistinctly bifurcated. There are traces of synapticulae.

Austrometra thetidis.—In a specimen with the arms about 40 mm. long the third brachial has 15 septa of which 5–6 are complete; the areola is rather narrow, but distinct, with a broad smooth area united with the ventral part of the joint face; the degree of strength is 2.

Clarkometra elegans.—In a specimen with arms 25 mm. long the third brachial had 11 septa, scarcely any complete, and a narrow indistinct areola; the degree of strength is 2–3.

Tropiometridae

Tropiometra afra macrodiscus.—In a specimen with the arm length 190 mm. the distal end of the third brachial has about 52 septa, of which about 25 are complete, some of these being finished. The ventral portion of the joint face has rather irregular pits and a ring of tubercles which is synapticularly arranged. The areola is large and stout, protruding as a small cone that rises from a surrounding concavity. The degree of strength is 4. In another case there were 51 septa, about 27 complete.

Calometridae

Pectinometra flavopurpurea.—In a specimen with arms 70 mm. long the third brachial has 14 septa, 2 complete; the ventral beam is very broad, and the areola is broad and stout; the degree of strength is 2. The thirteenth brachial has 15 septa. The twentieth brachial (third hypozygal) has about 15 septa, which are similar to those of *Mariametra.*

Neometra multicolor.—In a specimen with the arm length of about 60 mm. the third brachial has 19 septa of which 5 are complete and 2 are ventral beams; the areola is broad and stout, though rather low; the degree of strength is 3. The thirteenth brachial (second hypozygal) has 15 septa, 5–6 of them complete.

Ptilometridae

Ptilometra mülleri.—A specimen with an arm length of 50 mm. has the fifth brachial (first hypozygal) with 21 septa, two of them indistinct ventral beams; the areola is indistinct; the degree of strength is 3. A concentric furrow is present, as in *Asterometra*, but closer to the periphery of the ossicle. The fifteenth brachial has 19 septa, about 9 complete. The twenty-third brachial (third hypozygal) has 18 septa, of which 7 are complete.

ASTEROMETRIDAE

Asterometra anthus.—In a specimen with arms 80 mm. long the third brachial has 29 septa, of which 14 are complete; in some cases the septa are forked; the areola is narrow; the degree of strength is 3. There is a concentric furrow about midway between the periphery of the joint face and the central lumen. In another case there are 27 septa. The ninth brachial (second hypozygal) has 28 septa.

THALASSOMETRIDAE

Stylometra spinifera.—In a specimen with arms about 90 mm. long the third brachial, following a IIBr axillary, has 23 septa, of which 9 are complete and 2 are indistinctly separated ventral beams; a couple of septa are forked, and some of the ventral ones are partly subdivided into rows of tubercles; the areola is broad and stout; the degree of strength is 3–4. Two third brachials following a IIIBr axillary have 19 and 20 septa, with the ventral beam not subdivided; the areola is as before, but the septa are somewhat lower.

Oceanometra annandalei.—In a specimen with arms 80 mm. long the IIBr$_3$ has about 18 septa. The third brachial has 19 septa, including 6 complete septa and one ventral beam; the areola is broad, though rather low; the degree of strength is 2–3. The septa are stout, running out as ribs to the margin of the ossicle, and there is a marginal growth ledge.

Stenometra dentata.—In a specimen with an arm length of about 50 mm. the third brachial has 18 septa, 8 of which are complete and 2 are low ventral beams; the areola is rather narrow and indistinct; the degree of strength is 2–3.

CHARITOMETRIDAE

Perissometra cf. *aranea*.—In a specimen with arms about 80 mm. long the third brachial has 22 septa, 4 complete and 2 ventral beams; the areola is indistinct; the degree of strength is 2. The thirteenth brachial has 20 septa, 10 complete and 2 ventral beams. The eighteenth brachial has 19 septa and a narrow areola. The twenty-third brachial has 17 septa. The twenty-ninth brachial has 17 septa, of which 2 are complete. The thirty-fourth brachial (sixth hypozygal) has 14 septa, all incomplete, and no areola.

Crossometra septentrionalis.—A specimen with an arm length of 70 mm. has the IIBr$_3$ with 17 very low septa, about 7 incomplete, with the degree of strength 1. Three first brachials have 14, 14, and 16 septa. A third brachial has 16 septa, 4 complete and 2 ventral beams; the areola is of medium width, but low. The eleventh brachial has 15 septa, 3 complete and 2 ventral beams, with the degree of strength 2. In one case the articulation between the first two brachials is a compromise between a synarthry and a syzygy.

Diodontometra bocki.—In a specimen with the arms 60 mm. long the third brachial has 16 septa, 6–7 complete and the ventral beam weakly developed and partly divided; the degree of strength is 1; the areola is distinct.

NOTOCRINIDAE

Notocrinus virilis.—In a specimen with the arms 75+ (probably about 125) mm. long the third brachial has 18 septa, 3 or 4 finished and only 2 incomplete; the degree of strength is 2. The areola is narrow, but there appears outside of this a very broad almost smooth area occupying about half the space between the lumen and the margin of the ossicle. Beyond this area there is a stout concentric synapticula, and beyond this a similar weaker one. In another case there were 19 septa, about 4 incomplete. Two eighth brachials had 19 and 20 septa and 2–3 weak synapticulae; the degree of strength is 1.

ANTEDONIDAE

Antedon petasus.—In a specimen with arms about 80 mm. long the third brachial has 21 septa, 12 complete, and an indistinct areola; the degree of strength is 2–3. In another case there are 19 septa. The ninth brachial has 19 septa with an abnormally large and stout areola. The fifteenth brachial has 19 septa. The nineteenth brachial has 19 septa, of which 12 are complete, and a narrow distinct areola. In the last two hypozygals there is a distinct ventral beam.

Compsometra serrata.—In a specimen with an arm length of 30 mm. the third brachial has 14 septa, 9 complete, and a narrow areola; the degree of strength is 2. In another case there are 12 septa, about 10 complete. The ninth brachial has 13 septa, including 2 indistinct ventral beams. The fourteenth brachial (third hypozygal) has 14 septa.

Isometra vivipara.—In a specimen with arms 60 mm. long the third brachial has 14 septa, 10 complete; most of the septa are finished about halfway to the border of the ossicle; the areola is narrow; the degree of strength is 2. From the fourth or fifth syzygy onward septa are lacking, the union becoming a loose synostosis, with about the lumen a rather marked areola situated in the center of a somewhat concave face.

Heliometra glacialis.—In a specimen with an arm length of about 200 mm. the distal face of the third brachial has about 36 septa; there are 22 complete septa, about 6 ventral rows of tubercles, and 2–3 concentric synapticulae, of which the innermost is the stoutest; the areola is dorsally rather moderate, ventrally very broad; the degree of strength is 4. In two other cases there are 39 septa, 22 complete, 6 rows of tubercles, and 2 ventral beams. The twenty-sixth brachial (sixth hypozygal) has 29 septa, including two ventral rows of tubercles; the septa are somewhat lower than those on the third brachial, and the areola is narrow.

Promachocrinus kerguelensis.—In a specimen with arms about 150 mm. long the third brachial has 27 septa, 11 of these incomplete, and on each side of the median line 3–5 ventral tubercle rows; the degree of strength is 4. In another case there are 30 septa including 8 rows of tubercles; the areola is narrow or of medium width, indistinct, sometimes lacking. The ninth brachial has 32 septa. The fourteenth brachial (third hypozygal) has 34 septa, including 7 ventral rows of tubercles; moreover, many of the septa are partly subdivided into rows of tubercles.

Leptometra celtica.—In a specimen with an arm length of about 70 mm. the third brachial has 24 septa, about 12 complete septa, 3 of these finished, and 2 ventral beams; the areola is narrow and indistinct; the degree of strength is 2. In another case there are 19 septa. The ninth brachial (second hypozygal) has 19 septa, and the fifteenth (third hypozygal) has 17 septa.

Psathyrometra wireni.—In a specimen with the arms about 60 mm. long the third brachial has 16 septa, of which 11–12 are complete; the areola is narrow and indistinct; the degree of strength is 1; there is one indistinct concentric synapticula. The ninth brachial (second hypozygal) has about 16 very low septa.

Poliometra prolixa.—In a specimen with arms about 100 mm. long the third brachial has 21–22 septa, of which 13 are complete; the areola is ventrally in broad contact with the smooth ventral part of the ossicle, dorsally narrow and indistinct; the joint face is somewhat undulating; the degree of strength is 2. In another case there are about 22 septa. The ninth brachial (second hypozygal) has 21 septa, and the ninteenth (third hypozygal) has 18 septa.

Hathrometra tenella var. *sarsii.*—In a specimen with an arm length of about 50 mm. the third brachial has 22 septa, including 9 complete septa and 2 ventral beams; there is no areola; the degree of strength is 3. In another case there were also 22 septa. The ninth brachial (second hypozygal) in two cases had about 18 septa. The fourteenth brachial (third hypozygal) in two cases had 18 and 19 septa; the degree of strength was 2–3.

PENTAMETROCRINIDAE

Pentametrocrinus diomedeae.—In a specimen with the arms about 100 mm. long the distal face of the fourth brachial (first hypozygal) had 18 septa, including 11 complete septa and 2 ventral beams; the areola was scarcely indicated; the degree of strength was 2–1. The ninth brachial had 16 septa.

Thaumatocrinus jungerseni.—In a specimen with the arms about 70 mm. long the distal face of the fourth brachial (first hypozygal) had 11 septa, including 5–6 complete septa and 1 ventral beam; there was no areola; the degree of strength was 2–3. The ninth brachial (second hypozygal) had 11 septa, including 2 ventral beams. The sixteenth brachial (third hypozygal) had 11 septa, including 5 complete septa and 2 ventral beams.

ATELECRINIDAE

Atelecrinus helgae.—In a specimen with an arm length of perhaps 90 mm. the third brachial had 10–11 septa, including one broad ventral beam with a small ventral pit, about 10 complete and finished or interrupted very narrow septa, four of them tubercles only, and 3 ventral tubercles continuous with the ventral smooth part of the ossicle; there was no areola; the degree of strength was 2–3. The seventh brachial (second hypozygal) had 12 septa, including 11 very narrow and rather complete septa and one ventral beam. The degree of strength is 2.

Atopocrinus sibogae.—Gislén said that if the author's statement that two small ventral muscle bundles occur in the syzygies of this species can be verified this species presents syzygial unions of a very interesting and ancient type, reminding one of the oldest articulate type. He has, however, never been able to find any trace of rudimentary muscles in ligamentary articulations in sections through arms of young comatulids, in regenerating arms, or in ligamentary unions in *Ptilocrinus pinnatus*, *Rhizocrinus lofotensis*, or *Ilycrinus carpenterii*. Until it has been verified, he wrote, he prefers to regard the statement with some reservation.

SUMMARY

Gislén said the author's statement that the number of syzygial septa is "to a certain extent proportionate to the size of the articular face, and is greater in the Oligophreata than in the Macrophreata" in general holds good. But there are some important exceptions, especially to the latter assertion. For instance, the oligophreate families Calometridae and Charitometridae have unusually few septa, and the same is true in regard to most of the Thalassometridae and certain of the Colobometridae.

Comasteridae.—The septa in the proximal syzygies are usually numerous (30–58), below 20 only in small forms. The degree of strength is 3–4. The areola is strongly developed, but rather narrow. Plenty of tubercles occur, often also ventral tubercle rows. Pseudosyzygies sometimes appear among species of the genus *Comaster* between the first two post radial ossicles (the elements of the IBr series). These, like typical syzygies, often replace synarthries. The distal intersyzygial interval is normally 3–4 muscular articulations (an exception in *Capillaster*).

Zygometridae.—There are 16–30 septa in the proximal syzygies. The degree of strength is 2–3. The areola is indistinct. A syzygy replaces the most proximal synarthry. The young stages of these syzygies often remind one of the pseudosyzygies in *Comaster*. The number of incomplete septa is large. The distal intersyzygial interval is fairly short, 3 muscular articulations in *Eudiocrinus* (now assigned to a special family, Eudiocrinidae), and 4–8 in *Catoptometra*. In *Zygometra*, however, the interval is long, 10–30 muscular articulations.

Himerometridae.—In the proximal syzygies the septa number 35–50, with the degree of strength 2–3. The areola is indistinct. Sometimes there are 2 clearly marked ventral beams. The number of incomplete septa is rather large. The distal intersyzygial interval is long, (6) 10–26 muscular articulations.

Mariametridae.—The proximal syzygies have 25–40 septa, except in the delicately built genus *Mariametra* in which there are only 15. Gislén remarked that the heavily granulated disk also shows *Mariametra* to be a primitive type. The degree of strength is 2–4. The areola is well developed—in *Stephanometra* narrow but distinct. There are 2 ventral beams. Complete septa are few. There are occasionally incidental irregularities in the distribution of the proximal ligamentary unions, so that syzygies may replace synarthries. The distal intersyzygial interval is fairly long, 5–18 muscular articulations.

Tropiometridae.—The septa in the first syzygy number about 50, with the degree of strength 4. The areola is stout, raised on a conical prominence. There are a good many complete septa. The distal intersyzygial interval is 5–10 muscular articulations.

Colobometridae.—The proximal syzygies have 15–30 septa, with the degree of strength 2–3. The areola is narrow, distinct or indistinct. There is rather a large number of complete septa. There is great diversity within this family, *Cenometra* reminding one of *Liparometra*, *Oligometrides* of *Tropiometra*, *Cyllometra* of the antedonid type, and *Austrometra* most nearly of certain Thalassometridae. The distal intersyzygial interval is 3–10 muscular articulations.

Calometridae.—The proximal syzygies have 13–19 septa, with the degree of strength 2–3. The areola is broad and stout. There are few complete septa. The distal intersyzygial interval is 3–15 muscular articulations.

Thalassometridae.—The proximal syzygies have 19–29 septa, with the degree of strength 2–3. In the Ptilometridae (here included as a subfamily of the Thalassometridae) the areola is indistinct, whereas in the Thalassometridae it is generally broad and stout. Very often a concentric furrow appears parallel to the margin of the ossicle. The septa are sometimes forked. There are 1 or 2 indistinct ventral beams. The proximal syzygies in *Ptilometra* (Ptilometridae) and even in *Asterometra* (Asterometridae) are often irregular, sometimes also replacing synarthries. The distal intersyzygial interval is 5–10 (in exceptional cases 4–18) muscular articulations.

Charitometridae.—The proximal syzygies have 15–22 septa, with the degree of strength 1–2. The areola is usually indistinct. There are 2 ventral beams, more or less indistinct. The complete septa are rather few. Irregularities in the distribution of the proximal syzygies are usual, these often replacing synarthries. The distal intersyzygial interval is 5–10 muscular articulations.

Notocrinidae.—The proximal syzygies have about 20 septa, with the degree of strength 2. Beyond the narrow areola is a broad and almost smooth area. Synapticulae occur. Most of the septa reach to the large nearly smooth area, and to the areola. The distal intersyzygial interval is 4–10 muscular articulations.

Antedonidae.—The septa of the proximal syzygies have 11–24, and in the very large Heliometrinae 27–39, septa; the degree of strength is 1–3, reaching 4 in the Heliometrinae. The areola is lacking or indistinct except in *Heliometra,* in which in full-grown individuals it reminds one somewhat of the conditions described in *Notocrinus.* Rows of tubercles occur only in the Heliometrinae. There are many complete septa, these being usually more than half the total number. The distal intersyzygial interval is 2–4 muscular articulations.

Pentametrocrinidae.—The proximal syzygies have 11–18 septa, with the degree of strength 1–3. There is no areola. Half, or even the majority, of the septa are complete. The distal intersyzygial interval is 2–6 muscular articulations, and is rather irregular.

Atelecrinidae.—The proximal syzygies have few septa, not more than 12, with the degree of strength 2–3. There is no areola. The septa are generally complete, sometimes finished, and more or less like tubercles. The distal intersyzygial interval is 2–7 muscular articulations.

MOVABLE LIGAMENTARY UNIONS IN THE STALKED CRINOIDS

In the pentacrinites the ligamentary articulations are generally immovable, and more or less pronouncedly synostoses. In the division series and in the first brachial ligamentary union, however, evident indications of synarthries are sometimes present. This is the case in *Hypalocrinus naresianus* and in the species of *Neocrinus.* In *Neocrinus decorus* the distal synostoses seem to indicate a development from this toward the trifascial type of articulation.

The latter is typically developed in certain bathycrinids, such as *Ilycrinus carpenterii, Bathycrinus aldrichianus,* and *B. australis.* In *Rhizocrinus lofotensis,* as Sars showed and as Gislén confirmed, there is a form of loose synostosis in the ligamentary articulations. In *Democrinus rawsonii* there seems to be a type intermediate between a synarthry and synostosis. The Phrynocrinidae and Hyocrinidae lack movable ligamentary articulations.

MOVABLE LIGAMENTARY UNIONS IN THE COMATULIDS

Gislén noted that although the degree of flexibility is very differently developed in different forms, nevertheless the synarthrial type taken as a whole is generally the same. Cryptosynarthries may appear in the Comasteridae. In these, as in pseudosyzygies and in the usual syzygies, the flexibility is practically nil.

As viewed from the dorsal side synarthrial articulations show a fair amount of variation. The articular line may be straight and not accompanied by any process; there may be a more or less strongly developed synarthrial tubercle; or there may be a more or less strongly developed synarthrial backward projection.

Gislén said that it is important to differentiate between synarthrial tubercles and synarthrial backward projections. In the former only a dorsal prolongation of the synarthry occurs; this causes an enlargement of the synarthrial faces, but generally no increased flexibility worth mentioning, as the synarthrial fibers are not elongated. To the latter type, on the other hand, great possibilities as regards increased flexibility are always attached, with long ligamentary fibers in large lateral notches between the ossicles.

There is, as a rule, very little flexibility in the Oligophreata from the Comasteridae to the Calometridae. Among these the backward synarthrial projection is very slight or lacking. On the other hand in the Macrophreata, together with most of the Thalassometridae and Charitometridae, the synarthries permit especially strong lateral flexion, and the backward synarthrial projections are often enormously devoloped. These reach their maximum in the Zenometrinae and Bathymetrinae in the family Antedonidae. Extraordinarily strongly developed synarthrial tubercles appear sporadically in different families, for instance in species of *Amphimetra*, in *Neometra diana*, and in *Perometra diomedeae*.

Gislén said that in the youngest stages the synarthries tend toward synostoses, but a stout areola appears very early.

Another type of mobile articulation, trifascial ligamentary union or ligamentary articulation, with dorsoventral flexion only, is found in some cases in the recent comatulids. This appears only in the articulation between the radials and the IBr_1. It has been observed in *Pontiometra andersoni* and in *Stephanometra spicata*. Standing very near this type is the radial articulation in *Himerometra martensi* in which the muscles are indicated only as rudiments in the shape of low bands. In the Comasteridae and Calometridae also there is a form of articulation between the radials and the IBr_1 that approaches this type. This type of trifascial articulation, according to Gislén, possesses its greatest interest in that several of the Jurassic comatulids seem to have a similar articulation between the radials and the IBr_1.

Comasteridae.—From a pronounced synarthrial type the articulation seems sometimes to approach the cryptosynarthry, observed among the slender armed varieties of the species of *Comatula*. The species studied by Gislén have fairly typical synarthries. Divergencies from this have been observed in the synarthry between the elements of the IBr series. In large species, such as *Comanthus japonica*, the areola around the lumen is very extensive, and the two ligament pits are not equally curved, but are excavated irregularly, here and there. Here the possibilities of flexion are slight. The same is the case in those species of *Comaster* in which the synarthries are replaced by pseudosyzygies. The small species of *Comissia*, as well as *Capillaster sentosa,* have an articulation between the elements of the IBr series that approaches a cryptosynarthry. *Capillaster* may sometimes have only a single synarthry in each arm—between the first two brachials. *Comatula* and *Comatulella* (?) alone lack synarthries. Synarthrial tubercles and synarthrial backward projections are lacking.

Zygometridae.—The articulation between the elements of the IBr series is developed as a syzygy. Normal synarthries always appear between the two ossicles following each axillary. There are scarcely any synarthrial tubercles.

Himerometridae.—Gislén did not examine any of the synarthries in the IBr series, but he found that the following synarthries are typical. The synarthrial tubercles are often knoblike and projecting. There are no synarthrial backward projections.

Mariametridae.—In *Stephanometra* the synarthry in the IBr series shows a pair of deep and stout pits on either side of a fairly narrow dorsoventral beam. About the periphery is a broad contact margin. The capacity for movement is extremely slight. The more distal synarthries are typical. There are no synarthrial tubercles. The synarthry in the IBr series in *Lamprometra palmata* corresponds in a high degree to that in *Stephanometra.* The more distal synarthries are high and laterally compressed, as in all forms with numerous arms.

Colobometridae.—In *Pontiometra andersoni* the synarthry in the IBr series corresponds to that in *Stephanometra.* The more distal synarthries are high and laterally compressed, more so than in other multibrachiate types. There are indistinct synarthrial tubercles. In having rhomboidal joint faces *Oligometrides* represents a unique type. The synarthries in the other forms offer very little of interest. Synarthrial backward projections are absent or, if present, weak. Gislén studied the synarthries in the IBr series in *Austrometra, Cenometra,* and *Cyllometra.*

Tropiometridae.—The synarthrial faces of the articulation between the elements of the IBr series in *Tropiometra afra macrodiscus* remind one very much of the same faces in the large species of Comasteridae. The joint pits are scarcely marked plainly, are bounded indistinctly, and are rather shallow. The capacity for movement is slight. In the synarthries between the first two brachials the articular pits are not developed in a semilunar shape, but only the dorsal half of each half moon is found marked. Both the fossae, however, are well circumscribed here. Synarthrial tubercles are absent or indistinct.

Calometridae.—The radials are often produced anteriorly in the interradial angles between the IBr_1, and possibly as a result of this the first synarthrial face shows large wing-shaped appendages on both sides of the joint face. The union as seen from the dorsal side is often very close, and the mobility therefore presumably very slight. The fossae are, however, well marked. The more distal synarthries are of the usual type. Usually the synarthrial tubercles are indistinct, but they are extraordinarily large in *Neometra diana.* In *Calometra discoidea* there are synarthrial backward projections.

Ptilometridae.—There is never any synarthrial backward projection. The capacity for lateral motion is slighter than in the Thalassometridae.

Thalassometridae.—The contour of the synarthrial face is often somewhat angular, owing to the lateral flattening or "wall-sidedness" of the post-radial series. The synarthrial face is somewhat produced into an acute angle dorsally, where synarthrial tubercles are found. This is often developed in connection with longitudinal crests on the proximal brachials. There is often a synarthrial backward projection, and at the same time large notches between the ossicles, giving the capacity for increased lateral flexion. The appearance of the synarthrial face is much like that in the following family.

Charitometridae.—The synarthrial faces in this family correspond in many ways to those in the family preceding. There is often a longitudinal crest on the proximal ossicles, and sometimes synarthrial backward projections. There are often large lateral notches. The synarthrial face often shows a likeness to that of certain antedonids in being restricted to a rather small proportion of the joint face.

Notocrinidae.—The synarthrial face reminds one of that in the Thalassometridae. The median dorsoventral ridge is, however, extraordinarily stout, the areola surrounding the lumen very broad, and the ligament fossae deep. There are no synarthrial tubercles. There is a weak synarthrial backward projection.

Antedonidae.—Great variation is found in this family. Gislén said it looks as though one might trace the appearance of the synarthrial faces back to two types. The first of these is like that in *Asterometra* and *Notocrinus* in that the articular facet occupies practically the whole of the joint face, and the synarthrial backward projection is moderately developed; there are rarely any synarthrial tubercles (but these are strongly developed in the Perometrinae). The Antedoninae belong here, and also the Perometrinae and Isometrinae and probably the Thysanometrinae. The second type has the synarthrial facet restricted to the center of the joint face and beyond this a broad area without ligament fibers; the synarthrial facet is often produced dorsoventrally, and the backward synarthrial projection is generally enormous. Here belong the Heliometrinae, Zenometrinae, and Bathymetrinae.

Pentametrocrinidae.—The synarthrial facet occupies practically the whole of the joint face, but relatively somewhat less in *Pentametrocrinus.* It is narrower in *Thaumatocrinus*, evidently because of the 10 arms. The fossae are moderately deep. The synarthrial backward projection is distinctly pronounced in *Pentametrocrinus*, but imperceptible in *Thaumatocrinus.*

Atelecrinidae.—The synarthrial facet is very much like that in the Zenometrinae. The synarthrial backward projection is distinct.

ARTICULATIONS OF THE PINNULARS IN RECENT CRINOIDS

Gislén said that on the whole the pinnular articulations seem to be very uniformly constructed in all the recent crinoids, though there are wide variations in several details. The typical form may be described as follows.

The articulation between a brachial and the first pinnule is an articulation of rather ordinary muscular type. While the angle between the transverse ridges of the two joint faces on the distal end of an axillary is about 90° (for instance in *Heliometra* and *Himerometra*—the axillary being viewed from the distal end), the transverse ridges of the pinnule facet and of the brachial joint face form a considerably greater angle usually (*Heliometra* 115°, *Metacrinus* 150°, *Himerometra* about 165°, and Calometridae and other types 180°). The pinnule facet on the brachial is thus twisted nearly halfway around, so that the side that should be the outer lateral becomes the inner median, and vice versa. It reaches such a position that its muscular fossae still continue adjacent to the muscle pit of the pinnular side of the articular face of the brachial. The dorsal ligament of the pinnule facet, on the other hand, seems to be removed almost to the maximum distance from the dorsal ligament of the brachial facet, if the brachial be viewed in plane projection. The pinnule facet forms an angle of about 110° with the articular face of the brachial, in, for instance, *Heliometra* and *Himerometra*. At the distal end of the IBr_2 in *Metacrinus nobilis tenuis* the corresponding angle was 140°. The dorsal ligament of the pinnule facet is sometimes better developed on the side adjacent to the median part of the brachial, and narrower on the side facing the lateral portion of the brachial. On the ventral side of the transverse ridge the lateral portion, on the contrary, is always more strongly developed. The intermuscular crest or furrow therefore bends considerably toward the median part of the brachial. The proximal part of the first pinnular answers to the pinnular joint face described on the brachial. Here, however, the articular fossae are often indistinctly marked, and the joint face only bulges irregularly, especially in small forms. When the muscles in this articulation are contracted the pinnule is flexed aborally and toward the side of the arm.

The proximal and distal joint faces on the first pinnular are very nearly parallel. Also the distal joint face of the first pinnular shows here, usually, an almost straight muscular articulation. This, however, is oriented at about a right angle to the proximal facet of the ossicle, so that the transverse ridges of the two joint faces form an angle of about 90°. The proximal facet of the second pinnular corresponds to the distal facet of the first pinnular. In some comatulids this articulation is most strongly developed on the adoral side. On contraction of the muscles in this articulation the pinnule is flexed ventrally.

The distal end of the second pinnular also has a transverse ridge, and this again makes an angle of 90° with the proximal face of the ossicle; here, therefore, it is a dorsoventral crest. But the articulation between the second and third pinnulars is differentiated from the two preceding by the appearance of small ventral muscle bundles on either side of the ridge, and usually by the absence of the ligament pit which, if it is present, marks the boundary for the dorsal development of the dorsoventral crest. In these two features this pinnular articulation differs from a synarthry that otherwise in its general character it rather strongly resembles. As is shown by examples from the distal segments of the distal pinnules it may be considered as derived from an ordinary muscular articulation through the disappearance of the dorsal ligament.

When asymmetry occurs in this and the following articulations it is the aboral side of the joint face that becomes the more strongly developed. This is contrary to the conditions found in the articulation between the first and second pinnulars (with some exceptions, as for instance *Metacrinus*). This stronger aboral development of the articulations of the distal pinnules expresses itself very strikingly in the development of the combs in the Comasteridae, and of the calcareous flanges protecting the gonads in *Austrometra, Isometra,* and certain Charitometridae.

The ventral pits on either side of the dorsoventral crest for the reception of the muscle bundles are usually least distinct in the articulation between the second and third pinnulars, where they may even be entirely lacking; but in the articulations following they are usually well circumscribed. In the not uncommon autotomy of the pinnules the fracture therefore always occurs between the second and third pinnulars—the articulation that comes nearest the ligamentary articulation of the arms.

The articulation between the third and fourth pinnulars, like all those following, is similar to that between the second and third, but the pits for the muscular fossae are better marked. The development of the muscle bundles shows great variability. In the distal parts of the proximal pinnules the movement thus takes place laterally.

In the distal articulations of the distal pinnules there is usually a pit in the dorsal portion of the dorsoventral crest. This pit harbors a little dorsal ligament. Here a possibility is present for slight flexibility also in a dorsoventral direction, most strongly developed in certain Comasteridae, as for instance *Comatulella brachiolata*.

Hyocrinidae.—In *Ptilocrinus pinnatus* the transverse crest of the face of the pinnular forms an angle with the brachial articular face of over 150°. The calcareous lamella over the muscle insertion projects forward as a large spout-shaped process. The proximal joint face of the first pinnular is peculiarly twisted in relation to the distal face on the same ossicle. This last face is a straight muscular articulation without interarticular ligaments. The second and following articulations are very close; they possess a dorsal ligament pit, but except for this lack nearly all sculpture. As is evidenced by sections these unions are in reality synostoses and therefore lack muscles.

Pentacrinidae.—The two muscle attachments on the pinnular face of the IBr_2 in *Metacrinus* are very small and close together. They project rather a long way into the brachial, and are overshadowed by a projecting calcareous lamella. The proximal face of the first pinnular makes an angle between the transverse ridge and the intermuscular furrow of about 50°, this angle facing toward the median portion of the brachial. The distal end of the first pinnular shows a typical straight muscular articulation with the adoral parts most strongly developed. The distal end of the second pinnular shows only indistinct traces of muscular attachments. As in the immediately following ossicles the adoral side is the one most strongly developed. The synarthroid type of articulation is very little accentuated here, the union approaching the synostotic. There is, however, a dorsal ligament pit. The joint faces, which follow rectangularly in transverse section, have small ventral muscle pits and retain the dorsal ligament pit; the ligament pits are shallow, becoming very insignificant distally. The dorsoventral crest is bounded dorsally by the dorsal pit.

The articulations of the distal pinnules show the same type. The dorsal pit is retained, and the dorsal ligament fossa is more distinctly accentuated. The distal segments of the distal pinnules in transverse section are either rectangular (*Metacrinus*) or triangular (*Diplocrinus*) and have only a very thin calcareous bridge separating the furrow for the ventral soft parts from the dorsal nerve. This thin bridge is often sievelike (?for the ciliated pits) and the joint therefore acquires—as seen from the ventral side—a certain likeness to the Silurian forms transitional between the canaliculate and noncanaliculate types.

As seen in transverse section the pinnulars of the Pentacrinidae, by their rectangular or triangular form, remind one rather strongly of those found in the Thalassometridae.

Bathycrinidae.—In this family pinnules are absent from a number of the proximal brachials. The pinnular joint face on the more distal brachials reminds one rather strongly of that in *Ptilocrinus.* The articulation between the first and second pinnulars is a muscular articulation of the usual brachial type. The dorsal ligament is, however, narrow and inconsiderable. The distal pinnule segments are distinguished chiefly by the large and extraordinarily thin lateral processes arising from the body of the pinnule segment itself and embracing the ventral soft parts.

Comasteridae.—Aside from the development of combs, the most characteristic feature of the pinnules in this family is the enormously strong development of the muscle bundles, which is especially remarkable in view of the weak development of the muscular unions between the brachials.

The angle that the transverse ridge of the brachial face and that of the pinnular face make with each other varies from about 130° in *Comaster* to 180° in *Comissia* and *Capillaster.* The cavity in which the muscles of the first pinnular are inserted on the brachial is usually not very deep. In the proximal comb-bearing pinnules very strong muscle attachments appear, which occupy the greater part of the surface of the facets of the articulations beyond that between the second and third pinnulars. This speaks in favor of these pinnules being specially adapted for making rapid and powerful movements. In the distal parts of the pinnules, where the combs occur, muscles are developed which are enormously more powerful on the side of the dorsal crest on which the teeth are developed.

In the distal combless pinnules the muscles are more moderately developed. In the articulation between the third and fourth pinnulars and beyond there appears as usual a small dorsal ligament fossa.

Zygometridae, Himerometridae, Mariametridae, Colobometridae, and Tropiometridae.—Except in unusual cases the muscular attachments are everywhere small. The pits in the brachials into which the muscles from the first pinnular are inserted are usually fairly deep, but there are some exceptions, as in *Himerometra.* Between the second and third pinnulars scarcely any muscular fossae are found in the large proximal pinnules of *Himerometra.*

In the very long and flexible P_1 in *Pontiometra andersoni* the articulations beyond the one between the second and third pinnulars are provided with large lateral muscular fossae. In the more distal parts of the pinnule, as in the distal pinnules, the dorsal part of the dorsoventral crest disappears, and we therefore get a more or less distinctly marked dorsal ligament fossa. It must be observed that the lumen in this pinnule is unusually large. We may compare the conditions here with the size of the lumen in the immovable proximal pinnules in *Stephanometra.*

Gislén remarked that in this connection it may be pointed out that the Macrophreata, provided with large brachial muscle attachments, have in the same way large nerve lumina in the brachials, and a large central organ for these nerves in the centrodorsal. Stout dorsal nerves are thus correlated with large muscle bundles and a strong capacity for movement or swimming.

In *Stephanometra* the stiff and styliform proximal pinnules differ considerably from the rest of the pinnules in regard to their articulations. The articulation between the first and second pinnulars is, as usual, a muscular articulation, and that between the second and third pinnulars is a pinnular articulation in which, however, only the muscle of the aboral side is noticeably developed. In the articulation between the third and fourth pinnulars there is a great reduction of the sculpture of the joint face, and from the articulation between the fourth and fifth pinnulars onward we get typical synostoses. This gives the styliform appearance and the stiffness to the pinnule. In certain of the Colobometridae there is a similar, though usually not so extreme, stiffening of the proximal pinnules.

In *Austrometra* the genital pinnules are provided with winglike processes, as is the case in the Bathymetridae. Here, however, the processes are extended almost horizontally so that the ossicle acquires a more disk-shaped appearance.

Calometridae, Thalassometridae, and Charitometridae.—In all these families the pinnule segments after the third or fourth are decidedly triangular, though the more proximal segments—the second-fourth—in the proximal pinnules are sometimes rectangular. The triangular form of the pinnulars may sometimes be indistinct in the proximal pinnules, these being more or less rounded, as in *Neometra* and *Stylometra.* In these families the genital pinnules often have flattened segments with small lateral processes that protect the gonads.

In the family Calometridae the proximal pinnules have enormously enlarged first and second pinnulars. The pinnule face on the brachial occupies a great part of its ventral surface. The muscle attachment pushes its way rather deeply into the brachial segment, as is usually the case also in the two other families. The transverse crest of the pinnular face is twisted to an angle of at least 180° in relation to that of the brachial face. The articular fossae between the proximal pinnulars are extraordinarily well developed in all the proximal pinnules. The interarticular ligaments are narrow or rudimentary. The union between the second and third pinnulars soon, however, becomes much closer than those between the other segments, and after about P_7 acquires a synostotic character that is especially evident in *Neometra.* Processes are also found on the earlier ossicles of the proximal pinnules, though less localized or marked, in some of the Charitometridae, and outside of this group in *Catoptometra* and in certain comasterids, as for instance *Comanthina belli.*

Notocrinidae and Macrophreata.—Gislén remarked that in regard to these forms there is not much to be said. Within this group the muscle attachments are very well developed; otherwise the pinnule articulations are fully typical, except for the cases mentioned below. The distal segments of the distal pinnules are more or less rounded, and their joint fossae are provided with the usual small dorsal fossa.

The more important exceptions to the typical structure are the following. The Heliometrinae have long proximal pinnules with very short segments. Here the pinnular muscle fossae are very strongly developed and the hypertrophy culminates between the distal pinnulars where, as in the Comasteridae, the most powerful muscle is found on that side of the ossicle where the rudimentary comb is situated—the aboral side. Another exception to the normal structure is found in *Isometra.* In this genus the third and fourth segments of the pinnules from about P_6 are greatly expanded, evidently to serve as a protection for the gonad. The hypertrophy is most strongly pronounced on the aboral side.

Gislén had no opportunity for studying the pinnules of the Thysanometrinae or Atelecrinidae.

THE PINNULE GAP

The earliest pinnules, appearing at the ends of the arms, are not formed until the arms have developed a certain number of brachials. The gap between these and the arm bases is filled by the successive appearance of P_1, then usually P_3, and finally P_2 and P_4. Gislén pointed out that in the Macrophreata the first pinnules appear on the tenth-twelfth brachials when about 15 brachials have developed. In other comatulids the pinnule gap is possibly in certain cases somewhat smaller, and possibly the formation of the proximal pinnules does not always take place as regularly as was assumed by Mortensen. In full-grown comatulids the pinnule gap is retained in *Atelecrinus,* in which up to 15 brachials lack pinnules, and in a reduced degree in *Comatilia, Hypalometra, Clarkometra, Balanometra,* and *Pentametrocrinus,* as well as in certain Colobometridae and Perometrinae. In the two last-mentioned groups, however, only P_a and in rare special cases P_1 are lacking.

Gislén said that the author has attempted to explain the cause of this by assuming that the comatulids, before the appearance of the first pinnules, might be considered "a fairly typical representative of the Flexibilia Impinnata." He remarked that the author also mentioned several other similarities to this group that support the assumption of a closer relationship. Regarding that portion of the arm proximal to the second syzygy these assumed similarities are: (1) Short, oblong, wedge-shaped brachials. (2) Absence of syzygies after the first syzygial pair—a corollary, according to Gislén, of the preceding. Gislén noted that the author said the interval between the first and second syzygies is the greatest in the whole arm, but that in reality this concerns only those comatulids that have very short intersyzygial intervals distally, and the second syzygy at about the tenth brachial. In certain Mariametridae, in *Ptilometra,* and in the Notocrinidae, Pentametrocrinidae, and Atelecrinidae, the interval is often very short, and the second syzygy appears as early as about the seventh brachial. (3) Before the second syzygy the pinnules are said to "be absent until after the brachials are completely formed;" Gislén says that this sentence becomes explicable only if understood as meaning "until after the brachials that form the second syzygial pair are completely formed." This assertion, according to Gislén, does not concern forms in which the second syzygy first appears far out on the arm—certain Oligophreata.

Gislén said that according to the author there often appear among the young of comatulids these similarities to the Flexibilia Impinnata: (1) All the brachial articulations are of the same nature. This, he says, is not correct, for when the earliest pinnules begin to be developed muscular and nonmuscular articulations can be distinguished histologically. (2) The flexibility of the arm is caused by a continuous ventral muscle band which is not subdivided into interbrachial muscles. Gislén remarked it is easy to prove by dissecting or sectioning young comatulids that interbrachial muscles really occur. There are also other similarities found there, but they are of a too general nature to point directly toward the Flexibilia Impinnata—Gislén remarked that, except for the paragraphs concerning the pinnule gap and the formation of a centrodorsal, they might just as well be mentioned as similarities with the Inadunata.

Gislén said that for a long time the pinnule gap was a puzzle to him, until at last through comparison with the condition in *Phrynocrinus* he began to see the matter more clearly. In *Phrynocrinus* the disk extends outward at least as far as the twentieth brachial, half burying a number of pinnules in the perisome. The first pinnules appear at about the eighth brachial. Proximal to this they are suppressed completely, evidently because, even if they had been present, they would have been far from reaching up to the surface of the disk and therefore would have been of no use for obtaining nourishment here. It seemed to Gislén that if the pinnule gap were attributable to historical factors something similar should be found in the fossil ancestors of the comatulids.

In all the smallest specimens of recent pentacrinites known—species of *Metacrinus* and *Neocrinus decorus*—all the pinnules are developed, and the proximal pinnules are the largest. There is no gap in the pinnulation.

Gislén said it was not until he turned to the fossil species of *Pentacrinus*—the genus that, according to him, most closely approaches the comatulids—that he found the solution of the problem. In *Pentacrinus* the ventral perisome rises to a height of half the length of the arms, to the fifth or sixth arm division, or to at least the fortieth brachial if all the series are reckoned consecutively.

In *Heliometra glacialis*, which has an unusually voluminous disk, this reaches, when the arms are folded and seen in profile, up to the fifteenth to the eighteenth brachial, and the anal tube in one case was observed to reach to the twenty-first brachial; when the arms are extended the disk reaches only to the eighth brachial, or to the height at which it is joined to the arms. In *Notocrinus virilis* the disk with the arms folded reaches to the eighth or ninth brachial, and joins the arms at the fifth or sixth brachial. In full-grown individuals of *Hathrometra tenella* var. *sarsii* the disk is attached at the third or fourth brachial, and when the arms are folded to the fifth to seventh brachials; in this species the anal tube is very long and reaches to the twelfth brachial. In the pentacrinoids of this species the disk reaches about as high as it does in full-grown individuals, or to the sixth brachial, the anal tube reaching to the tenth brachial, though the brachials are relatively longer in the young than in the fully grown. In still smaller pentacrinoids in which the budding of the pinnules in the distal part of the arms has only recently begun the disk reaches only to the first brachial, and the anal cone to the fourth; but in these pentacrinoids the reduction of the basals and radials has not as yet set in to any appreciable degree.

According to Gislén the difference in the height of the disk with the arms extended or brought together is hardly noticeable in forms having thin disks. For instance in *Heterometra crenulata* the disk is attached as far as the sixth or seventh brachial but does not reach noticeably higher when the arms are folded. In *Asterometra anthus* the disk reaches to the third brachial.

If the proximal pinnules are very long and slender they may, in spite of a fairly high disk, be of use in taking up nourishment or in functioning as tactile organs about the mouth, as in *Heliometra glacialis.* With an enlarged disk, however, the point may be reached where the proximal pinnules cannot reach to the ventral side of the disk; they are then excluded from playing any part in conveying nourishment, or from functioning as tactile oral pinnules. If the perisome then bulged out around them and they became imbedded in it, evidently their reduction and disappearance would not be far off.

Gislén noted that this has often been the case in a number of species of *Pentacrinus*, and that the *subangularis* group of species shows evident reduction of the proximal pinnules. Chiefly on the basis of characters connected with the stem, but also bearing in mind the more or less strong reduction of the proximal pinnules, Gislén proposed the new generic name *Seirocrinus* for *Pentacrinus subangularis* and its immediate relatives.

Gislén said it is evident that the hypothetical ancestor of the comatulids unites in itself characters belonging to both *Seirocrinus* and *Pentacrinus, sensu stricto.* It approaches *Pentacrinus* in its short stem consisting, after the development of the first nodal, of nodals only, as well as by the strong cirri. He said that among known forms *Pentacrinus dargienesi* comes nearest to the comatulids. The stem did not reach more than 60–70 mm. in length, while the cirri were 100 mm. long. The comatulids approach *Seirocrinus* through the defective pinnulation that appears in their ontogeny, which probably, in Gislén's belief, is caused by the perisome once having swelled out between the arms.

Gislén noted that it is not only among the Articulata discussed above that a gap in the proximal pinnulation occurs. Among recent forms pinnule gaps appear in the adults of various stalked types. They are met with throughout the Bathycrinidae. In *Bythocrinus* the first pinnule appears on from the fourth to the twelfth brachial (in *Bythocrinus* cf. *braueri* on the fourth to the sixth brachials; in *B. braueri* on the eighth; and in *B. chuni* on the tenth to twelfth); in *Democrinus* (*rawsonii* and *weberi*) the lowest pinnule is on the sixth brachial; in *Rhizocrinus* (*lofotensis*) it is on the eighth; in *Bathycrinus* it is found on from the eighth to the tenth (in *Bathycrinus pacificus* on the eighth; in *B. aldrichianus* on the ninth; and in *B. serratus* on the ?tenth); in *Ilycrinus* it is found on from the ninth to the ?twelfth (in *Ilycrinus australis,* ninth to eleventh; *I. carpenterii* eleventh or twelfth; and in *I. complanatus,* tenth to twelfth); and in *Monachocrinus* (*sexradiatus*) it is found on from the tenth to fourteenth. In the Phrynocrinidae only the arms of *Phrynocrinus nudus* are known. The first pinnule appears here on the eighth brachial. In the Hyocrinidae also a proximal pinnule gap is found, as one pinnule to the right and one to the left is lacking. The first pinnule therefore appears on from the fourth to the sixth brachial, the variation being due to the difference in distribution of the syzygies.

Gislén said that if his idea that the bathycrinids are derived from the Bourgueticrinidae and the latter are descended from a form nearly related to the comatulids and thiolliericrinids is correct the explanation of the pinnule gap in the bathycrinids will be the same as that given in the case of the comatulids. The disk in the bathycrinids of the recent seas does not reach far up on the arms—in *Rhizocrinus,* with 5 arms, to the second brachial, and in *Ilycrinus* with 10 arms also to the second brachial (fourth postradial ossicle). Gislén said it seemed to him in many cases as though this may be explained partly by the disk having sunken in between the greatly elongated basals (in *Bythocrinus, Democrinus,* and some species of *Monachocrinus*).

In *Phrynocrinus* the very large disk reaches up to about the twentieth brachial. The disk and arms of *Naumachocrinus* are not known; in this genus the radials are greatly elongated.

A high disk is also found in certain of the Hyocrinidae. In *Ptilocrinus,* in which it extends to the sixth brachial, the arms are grown fast together as far as the fifth brachial. In *Calamocrinus,* in which the disk is connected with the arms up to the ninth or tenth brachials, the anal tube reaches to the $IIBr_3$ (the axillary tenth postradial ossicle). On the other hand, *Thalassocrinus* and *Hyocrinus* have low disks. The position of *Gephyrocrinus* is intermediate.

Gislén concluded that a voluminous disk is of very common occurrence among the primitively organized Articulata. Sometimes this high disk is combined with loss of the proximal pinnules. In the comatulids, according to him, there is evidence that defective pinnulation was once present in the occurrence of a proximal pinnule gap during the juvenile stages.

According to Gislén the genital glands of the pinnules are to be considered as originally processes from the primitive gonad, to which the present axial gland corresponds, losing their connection with it only at a later stage. There is no definite correlation between the pinnule and the gonad, as has been assumed, for in some recent forms, as *Metacrinus*, *Notocrinus*, and *Comatula*, the gonads do not appear in the pinnules, but in the arms. All the ontogenetic indications point to a late migration of the gonads into the arms and pinnules. We may therefore suppose, according to Gislén, that the ventral sack originally enclosed, besides a part of the intestine, at least a part of the gonad. When the ventral sack later absorbed the whole of the disk, we may assume that the gonad extended under all the interadii. The perisome then rose between the arms and caused, at least in a number of forms, a reduction of the proximal pinnules. When the disk once more dwindled in size the migration of the gonads into the arms began. In a number of forms there still remains, as a reminder of the high disk and pinnule reduction, a proximal pinnule gap in the adults, best marked in the Bathycrinidae and Atelecrinidae, and appearing during ontogeny in all comatulids.

Gislén said it is noticeable that the Flexibilia, which never developed pinnules and had no ventral sack, always had a perisome extending high up between the arms.

Gislén remarked there seemed to him to be a certain amount of interest in trying to ascertain the total volume of the gonads in some of the comatulids. He therefore detached all the gonads from an arm in some specimens with greatly swollen genital pinnules, weighed the mass thus obtained, multiplied this by the number of arms, and divided the result by the specific gravity (1.1), and in this way obtained the total volume of the gonad. From this he calculated the height to which the disk would be raised were the gonads included in it, obtaining the following results: *Heliometra glacialis* (with the genital pinnules relatively inconspicuously distended), weight of gonads, 7.43 gr.; volume, 6.76 cc.; radius of the disk 10.5 mm.; raising of disk by inclusion of the gonads, 19.5 mm., corresponding to 14 brachials. As the disk reached to the tenth brachial, a disk with the gonads included within it would reach to about the twenty-fourth brachial. *Antedon petasus;* weight of gonads, 0.53 gr.; volume, 0.48 cc.; radius of the disk, 3.3 mm.; raising of disk by inclusion of the gonads, 14.1 mm., corresponding to 18 brachials. As the disk with the arms folded reaches to the seventh brachial, a disk with the gonads included would reach to about the twenty-fifth brachial. *Compsometra serrata;* weight of gonads 0.36 gr.; volume, 0.33 cc.; radius of the disk, 3.4 mm.; raising of the disk by inclusion of the gonads, 9.1 mm., corresponding to 16–17 brachials. As the disk reaches to the sixth brachial, it would reach, with the gonads included, up to about the twenty-second brachial. Gislén said that it seemed as if the enlargement of the disk under the conditions given above was rather considerable and fully sufficient to account for the reduction of the proximal

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pinnules. He said further that this assumption of the extension of the gonads under the interradii being the chief cause of the enlargement of the perisome makes it clear also why in young comatulids we do not get a high disk in connection with the pinnule gap, for at this stage the gonads are wholly rudimentary.

Dr. Gislén's explanation of the pinnule gap is most interesting and ingenious and certainly is worthy of serious consideration. But the author still maintains his belief in his own interpretation of the conditions in the early pentacrinoids. There is, of course, the possibility that both of us are in error in ascribing the pinnule gaps in the recent crinoids to factors having their origin in phylogenetical antecedents. These gaps may well be nothing more than a response to the conditions of environment with no phylogenetical background at all.

In the case of the developing young of the comatulids the prime requisite is to secure food as early as possible. The larger the diameter of the circle combed by the food-collecting organs, the larger is the potential food supply. So pinnules first appear at the tips of the growing arms, where it is obvious they will be most effective. With the commencement of concentration of food upon the disk, resulting from the action of the pinnules at the arm tips, the protection of the disk becomes increasingly important, so that it would be natural to expect the tactile pinnules at the edge of the disk to put in an appearance. The need for the intermediate pinnules, which are either genital or supplementary tactile pinnules, or both, does not arise until later, so that their development is delayed in favor of that of the more important pinnules.

The absence of a varying number of basal pinnules in such types as the Atelecrinidae and Bathycrinidae is probably due to the fact that, as a result of the crowding of the arm bases, there is no room for them. If present they would be without value to the animal, and so they are not developed. Such an explanation is easy to comprehend if pinnules are regarded in the light of articulated appendages, but is less easy of comprehension if they are considered as reduced arm ramifications.

INTERRELATIONSHIPS OF THE COMATULIDS

Gislén's rearrangement of the comatulid groups was given in detail in Part 3, pages 60–64. His notes on the evolution and interrelationships of the comatulids are of much interest, for his was the first serious attempt to harmonize in detail the systematic background of the recent and the fossil forms.

The evolution of certain comatulid characters.—Gislén said that originally cirri were arranged in five radial columns. It was not until the suppression of the internodals in the pentacrinite stem and the increased shortening of the nodals took place that two alternating columns occurred, to conserve space, in each radius. Since after the development of the centrodorsal the number of the cirri continued to increase a third column appeared, and finally the arrangement became a series of closely crowded irregular alternating rows. This developmental course may be traced more or less distinctly in the ontogeny of certain comatulids. Centrodorsals with closely crowded alternating rows of cirri are therefore the most highly specialized.

Originally the cirrus sockets had a distinct sculpture, but this has disappeared more or less completely among the younger forms.

The cavity within the centrodorsal was originally, as all the fossil comatulids show, from fairly small to very inconspicuous, never larger than in the corresponding recent forms. Gislén said it has been supposed by the author that from the considerably larger size of the centrodorsal cavity in the young we might conclude that a small centrodorsal cavity represents a more specialized stage. This feature according to Gislén has just as little phyletical significance as the longer segments in the young, and must be attributed to an as yet unfinished calcareous deposition in the walls around the chambered organ. Small and weakly calcified species always have, in comparison with the usual type in their family, an unusually large centrodorsal cavity.

The stronger development of the basals is a more primitive feature, noticeable both during the phylogeny and during the ontogeny of the comatulids.

The articular faces of the radials seem originally to have been moderately developed and to have had an inwardly broader muscular fossa of about the same size as the interarticular ligament. Later this muscular fossa was reduced to a low broad band which may even disappear entirely, as in the Comasterida or Mariametrida, or may become enormously enlarged in comparison with the interarticular ligament, as in the Macrophreata. This expresses itself in the ontogeny by the young of the group first mentioned having relatively larger muscular attachments, while the young in the latter group have relatively smaller ones. A small radial cavity is found only in the later comatulids, from the Upper Cretaceous onward. A radial cavity filled with spongy calcareous tissue is never found in the earlier comatulids, but occurs in the recent Comasterida and Mariametrida.

So far as we are acquainted with the fossil comatulids, syzygies appear in the older forms, but synarthries not until the younger ones. In the great majority of the older forms the syzygies seem to have been few in number, and their septa few. The arms were usually 10 in number, sometimes 5; if greater, the number of the component parts in the division series was very variable in older times.

The evolution of the comasterid type.—The oldest comatulids we know are found in the lowest Jurassic and belong to the comasterid type. Even then this type had a highly developed centrodorsal with small, closely set, alternating cirrus sockets, usually indistinctly or not at all sculptured, and rather strongly reduced basals. It may therefore be assumed that the comasterid type even at that remote period had a fairly long developmental course behind it. The primary characteristics of the older forms were the extremely small centrodorsal cavity and the inwardly broader fairly large muscular fossae on the radial articular faces. The characteristics which even today distinguish the comasterids were developed early. The first form without cirri is met with in the Lower Cretaceous. The centrodorsal is always more or less flattened. The radial fossae are from the very first vertical, and the radial cavity large, its central depression broad and deep, in recent forms filled with spongy calcareous tissue. The muscular fossae in the younger forms are low and broad. The arms in fossil forms are very little known, and so far as we are acquainted with them they are 5 or 10 in number and uniserial. Two unique features which in recent times especially distinguish this group are the exocyclic mouth and the pear-shaped organs instead of sacculi.

As primitive features which are retained in forms now living may be reckoned the clumsiness, the often undeveloped synarthries (as in *Comatula* and *Comaster*), the usually variable number of division series and of their component ossicles, the occasional plating of the disk, the covering plates in *Nemaster* and *Comatilia*, the occasional appearance of the gonads (best developed in the posterior radii) in the arms, and the creeping mode of locomotion. Specialized features are the reduction of the cirri, the numerous arms and syzygial septa, the powerful hooks on the distal pinnules, and the comb on the proximal pinnules and sometimes also on the distal ones.

The evolution of the solanocrinid type.—The solanocrinids appear first in the Middle Jurassic and become commoner in the Upper. Nevertheless they have centrodorsals that are more primitive than in *Palaeocomaster*, and the appearance of the cirrus sockets approaches more closely the pentacrinid type. Moreover, the basals in the oldest forms are strongly developed. It may be supposed, therefore, according to Gislén, that the solanocrinids developed into comatulids later than *Palaeocomaster*.

It is also possible that the solanocrinids are derived from a different branch of the pentacrinids. In *Palaeocomaster*, and in its descendants the recent comasterids, there is found a strong tendency toward reduction of the cirri, as in *Seirocrinus*. There is never any reduction of the cirri in the Solanocrinidae, which always have the cirrus sockets large and powerful, as in *Pentacrinus*. Possibly, therefore, the type first mentioned may have descended from a form more nearly related to the former pentacrinid genus, and the second type from a form more nearly related to the later one.

Among the solanocrinids *Archaeometra* is the most primitive in regard to the basals, which are very powerful. The cirrus sockets are still rather few and large. In *Solanocrinus* the number of cirrus rows and columns is increased, and in the Lower Cretaceous 15 columns of cirrus sockets become usual. In typical solanocrinids a centrodorsal with cirri in alternating rows is never attained. On the other hand, the genus *Solanocrinus* seems to show more primitive features in respect to the size and shallowness of the radial cavity and the sculpture of the cirrus sockets.

Gislén remarked it may now be asked whether the solanocrinids have completely died out, or whether they survive among the recent forms. The former has probably been the case with a number of clumsy forms from the Upper Jurassic with biserial arms. In addition to these there are in the Upper Jurassic, as well as in the Lower Cretaceous, quite typical solanocrinids with monoserial arms. Among the younger of these we find columns of large cirri on the flattened centrodorsal; but the sculpture of the cirrus sockets has almost disappeared, and the muscular fossae are low and broad and are possibly sometimes absent. The centrodorsal cavity still continues small and shallow; the radial articular faces lean only inconspicuously inward, and the radial cavity is therefore large—possibly it is beginning to be filled by spongy calcareous tissue.

It seemed to Gislén very probable that in the recent suborder Mariametrida we have the recent descendants of the solanocrinids. The difference is that the sculpture of the cirrus sockets in the younger forms has been still further reduced and therefore at its highest consists only of an areola, and that the cirri, generally at least, alternate distinctly. There are further the following specialized features—the reduction of the muscular fossae, distinctly indicated already in the Solanocrinidae, is often very advanced and sometimes complete (*Pontiometra* and *Stephanometra*); the radial cavity is generally filled up with spongy calcareous tissue; the syzygial septa have increased in number; and the basals are usually strongly reduced except in certain Himerometridae and in the family Tropiometridae of the Tropiometrida.

Gislén said that most of the primitive features are shown in the Zygometridae, certain Himerometridae, and the Mariametridae. Such features are: A syzygy between the elements of the IBr series in the Zygometridae; an indefinite number of components in the division series (in the Zygometridae and certain Himerometridae); few connecting fibers between the parietal and visceral layer of the coelome sacks in the disk so that the disk is easily thrown off (especially marked in the Zygometridae); the disk covered by calcareous granules; few syzygial septa (*Mariametra* and the Zygometridae); and undifferentiated proximal pinnules (Zygometridae and certain Himerometridae and Mariametridae).

The whole of the suborder Mariametrida, with the exception of the small genera in the Colobometridae, has a rather coarse and clumsy structure, a small and shallow centrodorsal cavity, and sparse syzygies. Among these features the two first mentioned and probably also the last are primitive. Besides, there are solanocrinid characters in the discoidal centrodorsal with rather stout cirri, as well as in the shallow and often meandering branched furrows that lodged the dorsal coelome between the centrodorsal and the radial pentagon.

In regard to the structure of the centrodorsal, and in the Comasterida and Mariametrida of the radial pentagon too, there seems, on the whole, to be evident a striving toward a similar ideal type. The further the comatulids progressed in their development, the closer they approached this goal as a rule, and it is therefore often more difficult to distinguish later forms of different groups than is the case with earlier ones. Gislén said that this explains also why the centrodorsal and radial ring in certain recent forms of Comasterida and Mariametrida, although in many instances easy to distinguish from each other, in some cases can not be diagnosed with certainty. The same is true with a number of younger fossil forms. There are types among the forms from the Upper Cretaceous known only from the centrodorsal that can only doubtfully be referred to the Comasteridae, or to the descendants of the solanocrinids. It seemed to Gislén that the *parvicavus* group of the genus *Glenotremites* may be assumed to belong to these latter because of the size of the cirrus facets. Presumably the *angelini* group may be referred here too. Gislén believed that in *Cypelometra* there is found a specialized descendant of the solanocrinids which as regards the appearance of the cirrus facets has reached the mariametrid stage.

The evolution of the notocrinid and conometrid types.—Gislén said that these two form series may be treated most suitably in connection with each other.

In the notocrinid series the most primitive type is *Loriolometra*, represented among the species belonging to *Glenotremites* by *G. arnaudi* and the *essensis* group. *Loriolometra* is continued by *Sphaerometra*, represented among the species of *Glenotremites* by the *paradoxus* and possibly the *rotundus* groups. With the genus *Semiometra* the type has acquired so many new features that Gislén believed it necessary to place it in the family Paleantedonidae. The series had originally rather few large cirrus sockets arranged in columns, with a weak transverse crest, often peripherally striated, protruding basals, broad free margin of the dorsal side of the radials, relatively large radial cavity, a more or less distinct dorsal star, and, most important of all, the specially characteristic deep radial pits in the centrodorsal for the reception of the dorsal coelome. The youngest representatives have numerous small cirrus sockets without sculpture, in alternating rows, concealed basals, no free dorsal margin of the radials, and a fairly small radial cavity; the radial pits are shallow or obliterated. Gislén observed a rosette in *Semiometra impressa.* He said that the recent form *Notocrinus* may properly be included in this series, as it is undoubtedly nearly related to *Loriolometra,* from which it differs in its shallower and wider radial coelome pits, by having a relatively larger centrodorsal cavity and, in full grown individuals, by the absence of sculpture on its cirrus sockets. The later forms of this series advance toward group *a* of the Macrophreata (see Part 3, page 63, under Macrophreata). The *lettensis* group with its fine radial pores corresponds as regards this character to the family Asterometridae in which the radial pits are deep, but very narrow.

The conometrid series, relatively poorly represented among species in which the radial pentagon is known by the genera *Amphorometra, Placometra, Conometra,* and *Jaekelometra,* is more numerously represented within the genus *Glenotremites* by the *anglesensis* and *peltati* groups. This series is distinguished from the preceding one by the absence of radial coelomic pits. Among recent forms it has its analogy in the Thalassometrida, *sensu stricto.*

Gislén said it is very remarkable what a large number of species of which only the centrodorsal is known are found in both these series, contrasting with the conditions in the solanocrinid series. In the genus *Glenotremites* of the solanocrinid type only five species are found (the *exilis* group). But there are 30 species that can certainly be included in the two series now under discussion. This is due in the case last mentioned to the fact that the elements of the radial pentagon are loosely connected both with each other and with the centrodorsal. In the recent Thalassometrida the corresponding ossicles very soon fall apart when boiled in caustic potash. A feature to be noticed is that in the recent Mariametrida the centrodorsal and the radial pentagon are very firmly united with each other, exactly as appears to have been the case in the fossil solanocrinids.

It seemed scarcely probable to Gislén that the notocrinids could have descended from any of the comasterids or solanocrinids. In the last named, to be sure, we sometimes find diverticula from the dorsal coelome between the centrodorsal and the radial pentagon, indicated by shallow branched meandering furrows. These, however, are entirely different from the deep and broad perpendicularly penetrating pits which occur in *Loriolometra.* Because of their depth—they traverse almost the whole of the centrodorsal even in full-grown individuals—it is easy to assume their prolongation into the stem in stalked young.

Although there are a good many similarities in regard to general features between *Archaeometra* and *Amphorometra,* Gislén said it is not very probable that the conometrids are derived from either of the two families first mentioned. This is made still less likely by the fact that in the Upper Jurassic we meet with a form which it seems might fairly well be considered a primitive ancestral form of the Thalassometrida and Conometridae in general, and of *Placometra* in particular.

Gislén said we therefore reach the conclusion in these two cases also that these two families possibly represent one, or perhaps two, special offshoots from the pentacrinid stock, which in that case have attained the comatulid type by independent paths.

In *Pterocoma pennata* from the Upper Jurassic we see a form exhibiting many features in common with certain comatulids from the Upper Cretaecous, as well as with the Thalassometrida. Gislén said that this early form does not show the least approach toward the contemporary solanocrinids. Possibly this species represents a type standing near the ancestral form of one or, perhaps, both the series mentioned above—Thalassometrida and Notocrinida. The slender habitus, the long undifferentiated rather scanty cirri, the numerous syzygies, and the prismatic pinnules with strongly developed side plates and covering plates all indicate that *Pterocoma pennata* should be placed very near the younger comatulid types and that it has nothing in common with the solanocrinids. Although masses of this species, otherwise almost perfectly preserved, are known, it is remarkable how very seldom the centrodorsal has been noticed. This is presumably due to the fact that the centrodorsal very easily becomes detached, and possibly also that at the animal's death it was left remaining upon a still existent stem. In the only specimen among 81 examined in which he found a centrodorsal preserved Walther observed and figured a large circular opening in the center of the dorsal side. Gislén said he had observed a similar pore on the dorsal side of a centrodorsal in a specimen he had examined.

Gislén said that a circumstance speaking in favor of the Thalassometrida and Notocrinida having reached the eleutherozoic mode of life at different times is the very different point of time at which their pentacrinoids become detached from the stem—in the former very early, in the latter type at a very late stage.

The Thalassometrida and the Notocrinida, according to Gislén, are the groups that in the recent seas have retained most of the features belonging to the stalked forms. These are especially numerous in the Thalassometrida—long cirri, somewhat rhombic in cross section; centrodorsal with the cirri in columns, sometimes in an almost simple radial column; basals relatively well developed; the free dorsal surface of the radials generally broad; the arm bases closely set and "wall-sided," the arms ending abruptly with an abortive portion bearing rudimentary pinnules; the pinnules prismatic to triangular in cross section; the side plates and covering plates strongly developed; and the disk often closely studded with calcareous granules or plates.

The evolution of the palaeantedonids.—Gislén said that *Semiometra* is a final type in the notocrinid series and constitutes a form transitional to the palaeantedonids, of which the genus *Palaeantedon* is typical. Gislén did not believe it possible to doubt that this genus represents a type corresponding to the recent antedonins, or in other words to group *a* among the Macrophreata. This is evidenced by the centrodorsal being closely set with numerous unsculptured cirrus sockets in alternating rows, by the large centrodorsal cavity, by the lack of any radial pores or pits on the ventral face of the centrodorsal, by the obliterated basals, by the large muscular fossae on the articular faces of the radials, by the inward sloping of the radial articular faces, by the slender oblique brachials, etc. The genus *Hertha* may be considered as a predecessor of the palaeantedonid type, specialized and characterized by the development of high narrow muscular fossae and a small radial cavity. The recent genus *Coccometra* typologically corresponds to the genus *Hertha*. The genus *Discometra* also comes very near the macrophreate type, although this type may prove to be a heterogeneous one. Among the recent Macrophreata belonging to group *a* the Antedoninae exhibit a number of more primitive characteristics, such as a relatively small centrodorsal cavity, rather inconspicuous muscular fossae, and weak synarthrial backward projections. It is interesting to note that we sometimes get here radial prolongations of the dorsal coelome that reach down to the ventral side of the centrodorsal and there form small and shallow pits.

It seemed very plausible to Gislén to assume that the second group of Macrophreata proceeded from a type nearly allied to the Thalassometridae, as well as to the fossil genera *Amphorometra* and *Conometra*. If we imagine a reduction of the side plates and covering plates in the thalassometrid type, we get a form extremely similar to the more primitive types within group *b*—the subfamily Zenometrinae. The size of the centrodorsal cavity for which this group *b* among more advanced forms is remarkable shows, as the synarthrial backward projection also does, a more moderate development in certain Zenometrinae. If it were a question of placing the genus *Conometra* in one of the recent groups it would be difficult to decide whether it should be referred to the Thalassometridae or to the Zenometrinae. In the same way it would be almost impossible, in certain cases, to distinguish between recent Thalassometrida and Zenometrinae if the centrodorsal and radial pentagon only were known. On the other hand, the genus *Amphorometra* shows, like *Placometra,* distinct points of contact with thalassometrid forms—with the Thalassometridae and Charitometridae. It seems hardly possible, according to Gislén, that the genus *Jaekelometra* can have been the ancestral form of the Atelecrinidae. There are certainly similiarites in the size of the basal ring, but the relative smoothness of the cirrus facets in *Jaekelometra,* the small size of the cavity in the centrodorsal, and the steep inward inclination of the radial articular faces which are provided with relatively insignificant muscular fossae differ radically from the conditions in the Atelecrinidae, in which the cirrus sockets have a strong crest and the centrodorsal cavity and radial muscular fossae are extraordinarily large. It appears, too, as if in *Jaekelometra* we are able to find an indication of the development of a rosette through thin centripetal continuations of the basals. No such formation seems to be present in *Atelecrinus.* Gislén therefore concluded that *Jaekelometra* is a type standing nearer certain primitive Thalassometrida.

Conclusions on the evolution of the comatulids.—Gislén said that his investigation of the mutual relations between the comatulids led him to assume the possibility of three, or perhaps four, different lines of stalked crinoids of the pentacrinid type having reached the eleutherozoic mode of life and become comatulids.

The first and oldest branch of the comatulids is represented by *Palaeocomaster,* to which the recent comasterids correspond. At the present time they still show their unique nature by the strong tendency toward reduction of the cirri, by the frequent occurrence of exocyclic forms, by the absence of sacculi, which are replaced by the pear-shaped organs, by the combs, and by the dorsal hooks. In contrast to all the other comatulids they have never acquired the capacity for swimming [not quite correct; see Part 2, page 602, fourth paragraph; page 606, second and last paragraphs], but still continue to employ a creeping mode of locomotion.

The second somewhat younger branch consists of the solanocrinids. We find among these in the Upper Jurassic forms having strongly biserial arms and very clumsily built. Gislén assumed that these were very probably creeping forms. Presumably this type has died out, while less specialized solanocrinids with monoserial arms have given rise to the recent Mariametrida. This group is more specialized than the solanocrinids in the appearance and arrangement of the cirrus sockets, the far advanced reduction of the basals, the development of the calcareous plug, the numerous arms, and the many syzygial septa. The relatively stout arms, the small centrodorsal cavity, and probably the relatively few syzygies may be considered as primitive characters that have been retained. In addition to these, the Zygometridae, Mariametridae, and certain Himerometridae show a number of primitive features.

The third group, which possibly has a double origin, is represented by the Notocrinidae and Conometridae. It is divided into two distinct series of which one, the Notocrinidae, leads toward the Palaeantedonidae and group *a* of the Macrophreata, while the other leads to the Thalassometrida and group *b* of the Macrophreata. A form that possibly may be interpreted as a prototype of one or possibly of both of these series is found in *Pterocoma pennata*. The Thalassometrida have preserved a number of pentacrinid characters in the long cirri, somewhat prismatic in cross section and arranged in radial columns, in the prismatic or triangular brachials and pinnule segments, in the relatively well developed basals, in the broad free dorsal surface of the radials, in the strong development of the side plates and covering plates, and in the granular covering of the disk.

The nearer one comes to the present time the more difficult it may become in critical cases to distinguish the types of these different groups from each other. If one excepts the comasterids, which have followed their own special course of development, and certain Mariametrida in which the reduction of the radial muscular fossae is strongly pronounced, the comatulid groups tend toward an ideal type of comatulid. For this reason it becomes extremely difficult to keep apart the converging forms that by different paths have approached this ideal type.

Gislén considered the subfamily Perometrinae as representing such a series, leading from colobometrid forms toward the antedonid type. He said it might have been desirable to divide the Macrophreata into more groups that could later have been placed at the apices of the different series of the older comatulid types. He did not choose to do this, however, as it seemed to him to be systematically impracticable and unfeasible. So he contented himself with depicting instead as nearly as possible, guided by the known facts, the different paths of development through which the distinctly emphasized polyphyletic character of the macrophreate group becomes explicable.

NOTES

Dr. Gislén regards the approach toward an idealized—perhaps more properly speaking generalized—type of comatulid that is evident in the several groups as convergence from originally distinct lines of different ultimate origin. To the author it seems more logical to reverse the picture and to assume a gradual divergence of the several groups from a number of types originally very similar and of an ultimate common origin. The comatulids have too many fundamental features in common that are not shared with other groups, even with the pentacrinites, to be considered polyphyletic.

From his generalizations Gislén omits the Comasteridae, which he said have followed their own particular course of development. He did not mention the genus

Comatulides (see Part 3, page 400), which is a very generalized type with little resemblance to other comasterids, and *Comatonia* (see Part 3, page 288), still more generalized, with a rounded conical centrodorsal, cirri in 3–4 irregular rows, strong synarthrial backward projections, and sacculi, he relegated to the Macrophreata, in spite of its perfectly typical and enormous comasterid combs.

It is quite true that some of the small species of the Colobometridae present a marked superficial resemblance to the species included in the subfamily Perometrinae. Nevertheless this resemblance is purely superficial, and the members of the two groups are always easily distinguished. The cirri are always thoroughly distinctive and show no tendency to intergrade. This confusion seems to have arisen in part from his disposition of the genus *Clarkometra*, which he assigned to the Perometrinae, whereas in reality it is a member of the Colobometridae, with perfectly typical colobometrid cirri.

The small species in the family Colobometridae bear approximately the same relation to the larger that the species of the genera *Comatonia*, *Microcomatula*, and *Comatulides* do to the larger comasterids.

Dr. Gislén's work on the fossil comatulids is of outstanding importance, and for the first time these puzzling fossils have been brought into a semblance of order. With all due respect for his excellent work, and for him personally, the author believes that far more detailed knowledge of the recent forms and their comparative structure, growth changes, life histories, etc., is necessary before their relationships with the fossils as a whole can be satisfactorily elucidated.

FOOD AND FEEDING HABITS

Gislén studied in great detail the feeding habits and the food of several recent crinoids. At the Kristineberg Zoological Station he studied *Antedon petasus* brought in from the outer parts of the Gullmar Fjord, where the species is found on a shell and gravel bottom at a depth of 30–40 meters. At the biological station of Haegdalen, Trondhjem, he studied *Hathrometra tenella* var. *sarsii* and *Rhizocrinus lofotensis* taken between Leksviken and Tautra on muddy bottom at a depth of 250 meters.

He found *Antedon petasus*, which he had had opportunities for studying in aquaria for a long time, at the beginning rather difficult to keep alive. It turned out that the temperature of the tank water supplying the aquaria with water was too high (16–18° C.). It was not practicable to use water brought up from the bottom directly, for as this cold water warmed up gas bubbles adhered to the pinnules of the crinoids, which floated to the surface and soon died. This was prevented by setting the vessel containing the animals on ice. Afterward by setting the aquarium, filled with water of very high salinity from the outer parts of the archipelago, in a tub filled with ice water he was able to keep *Antedon* alive and vigorous for weeks. The water did not need changing more than once every, or every other, week. The salinity of the sea water varied between 26 and 28 per thousand. The necessary supply of oxygen was obtained by means of an aerating apparatus of the usual type used at the station. The water was kept at a temperature of 10–12° C. — occasionally it was a couple of degrees higher or lower. It was soon found that it was not advisable to let the temperature rise higher than 14° C. With a higher salinity, however, the animals seemed able to stand a somewhat higher temperature. Thus they got on fairly well at a temperature of 15° C. when the sea water had a salinity of 30 per thousand. If the animals are to do well Gislén says it is absolutely necessary to supply the bottom of the aquarium with small pebbles or shells to which they can cling with their cirri, otherwise they fall over and soon die.

In the crinoids, as in other echinoderms, there occur on the surface of the body ciliary currents that serve the purpose of keeping the animal clean. These are most pronounced in the interradial and interbrachial areas of the disk. On the median parts of the interradial areas run centripetal (adoral) currents. These are checked at the oral angle by the upright adambulacral fold on the margin of the ambulacral furrow. Circular currents, therefore, running vertically, often arise in the oral angles. Along the sides of this median centripetally directed current the grains of carmine are carried radipetally, and in the area nearest the ambulacral groove centrifugally. As a result of this all the grains in the interradial area are gradually carried away along the margin of the ambulacral furrow. Where the ossicles in this upright margin are rather low, or where there is a gap between them, the grains are sucked down into the centripetal current of the ambulacral groove, and in this way most of the particles, even those falling upon the interradial areas, at last reach the mouth. Some of them, however, are carried out to the sides of the body and fall off the animal. The interbrachial parts of the perisome have ciliary currents going in an oropetal or radipetal direction. The oral pinnules are ciliated slightly toward their tips, and the grains of carmine carried thither thus sink down on to the surface of the disk and usually sooner or later reach the mouth. The anal cone is ciliated only at the base, where weak currents may be observed running upward. The excrement consists of the undigested particles from the intestine held together by a jellylike substance and formed into large yellow mucus balls. These balls are too large to be transported by the ciliary currents. They are removed from the surface of the disk, where they usually fall, by the movements of the animal when moving to another place, or by stronger movements of the water caused by the animal flexing its arms, etc. The cirri and the dorsal side of the animal are not ciliated but are kept clean by the movements of the animal.

Gislén said that the currents described above refer to *Antedon petasus*, but those of *Hathrometra tenella* var. *sarsii* are similar except that the marginal currents directed centrifugally may be followed further out on the sides of the arms. In *Rhizocrinus* the interradial currents are centripetal only.

When not irritated a hungry *Antedon* sits immovable with the arms outstretched and slightly curved upward. The pinnules extend out from the arm almost at right angles, and the tentacles, arranged in groups of three on the pinnules, are stiffly extended.

If a plankton sample or a few grains of carmine with some crab liver be put into the water of the aquarium the arms and pinnules at once become very active. The tentacles all beat rapidly inward toward the ambulacral furrow. This, the margins of which usually lie tightly pressed together, opens as soon as any grains fall upon it, with a wavy movement proceeding toward or away from the mouth. The mouth, previously only a narrow slit, opens to its widest extent and becomes circular. After some time the tentacles straighten themselves out again, but now and then when tiny grains fasten on the papillae the tentacles are whipped with rapid nervous movements toward the ambulacral groove, and then again straighten out as quick as lightning. Some of the groups opposite each other usually whip inward toward the furrow at the same time, but no flexing inward of the pinnules proceeding along the arms can be observed. Small particles are fastened to the tentacles by the secretion of unicellular mucous glands opening on the papillae, and with rapid motions of the tentacles are cast into the ambulacral groove where the ciliary current catches them and carries them to the mouth.

Sensory hairs are also found on the tentacles, and it has been supposed that these serve as sensory organs. The function of the tentacles, according to Gislén, is probably in reality manifold. First, they are certainly of considerable importance in respiration. Second, the mucus secretion, as pointed out above, serves to fasten the falling grains of plankton or detritus upon the tentacles temporarily. Third, the sensory cilia serve presumably in some way as an organ for taste and feeling. When Gislén dropped picric acid upon them the arms were flexed and relaxed violently; when he added a few drops of sublimate the arms were also rapidly bent and twisted, the pinnules were stretched out, and the animal made swimming motions as if in an endeavor to escape. On a third occasion quinine sulphate with a few grains of carmine was added. The arms were waved actively to and fro, the pinnules were flexed in to the sides of the arms or rubbed against each other, or laid over the place where the drops had fallen, the arms were turned upside down, with the evident intention of getting rid of the unpleasant matter. When old putrefying crab liver was added to the fluid containing the grains of carmine the pinnules were flexed in toward the sides of the arms. This seemed to Gislén to indicate that a sense of taste is present which presumably may be considered as localized in the sensory hairs of the papillae of the tentacles.

Gislén was unable to determine definitely whether, as maintained by Reichensperger, the secretion of the papillae of the tentacles is poisonous. He allowed living pinnules to lie in contact with freshly caught plankton (Ephyrae, peridineans, diatoms, and Plutei) but was unable to ascertain that any rapid unconsciousness or toxic action took place. A small *Cladonema* seemed to make motions of escaping when touched by a tentacle, but usually the tentacle bent away from the irritating object.

In the intestine of *Heliometra glacialis* Gislén has found quantities of copepods. The copepods have a tolerably strong power of motion of their own, and he said it is very probable that in this case the secretion of the papillae of the tentacles in some way paralyzes the prey as otherwise it is difficult to imagine how the relatively weak ciliary currents can transport the captured prey to the mouth.

The most proximal of the tentacles in each of the groups of three is the shortest and is directed straight upward, the middle one is longer and extends obliquely outward, and the most distal is the longest and is directed straight outward. On the arms this differentiation is indistinct, or is not marked at all. In the proximal parts of the arms and on the disk the tentacles are unbranched. The tentacles are often more or less contracted, but at the maximum extension the longest tentacle reaches from 0.5 to 0.7 mm. As the pinnules are placed at a distance of from 1.0 to 1.4 mm. from each other, with the maximum extension of the tentacles the region between the pinnules can be swept completely clean

The ciliary epithelium, characteristic of the ambulacral groove, begins at the base of every group of tentacles. The ambulacral furrow itself is slightly concave and ciliates strongly toward the mouth. The mucus is secreted in the ambulacral groove by the mucus glands, and by it the grains are fastened together into larger lumps, which are transported to the mouth, the edges of which are often pressed together like a pair of lips during movements similar to swallowing. The centripetal ciliary currents were also observed in *Hathrometra* and in *Rhizocrinus*.

In a healthy animal that does not receive any great amount of nourishment at one time the mouth is shaped like a slit. This slit in *Antedon petasus* is always oriented from the anterior radius toward the posterior interradius, or in the anterior half twisted a little to the left of the same line. Gislén observed a slit-shaped mouth with the same orientation in a specimen of *Thaumatometra comaster* preserved in spirit. In *Heliometra glacialis* the slit has the same orientation as in *Antedon petasus* but is directed a little more obliquely, from the right anterior interradius toward the left posterior radius, and the same condition is found in specimens of *Poliometra prolixa*, *Asterometra anthus*, and *Oligometrides adeonae*. The mouth is twisted still more in the same direction in *Tropiometra afra macrodiscus*, in which it looks as though it might become almost transverse in position, as in the Comasteridae. Most of the crinoids preserved in alcohol that Gislén examined have a rounded mouth opening, like sickly or dying individuals of *Antedon petasus*.

All kinds of small particles eddying up from the bottom owing to the movements of the animal or by currents in the water—mostly the latter—are carried to the mouth; in other words detritus and benthonic organisms, as well as some part of the plankton that rains down. Gislén's experience seemed to show that the benthonic nourishment is the most important. The following are analyses of samples of excrement from living animals examined:

Antedon petasus.—All the samples were brought home from Smedjan, Kristineberg, Sweden, where the animals were dredged from a depth of 30–40 meters.

1. A rough sample. The recently dredged animals were put into a vessel of sea water where they were allowed to stay for some hours, and the abundant excrement evacuated was collected. This contained detritus, small grains of sand, threads of algae, diatoms, some peridineans, crustacean larvae (0.3–0.5 mm. long), small copepods (0.09 by 0.18 mm.), macerated pieces of plants (one piece 0.40 by 0.60 mm.), and a half-digested myzostomid.

2. A lump of excrement taken directly from the anal opening contained detritus, diatoms (*Coscinodiscus*, *Navicula*, *Nitschia*, etc.), copepods, an ostracod, a veliger larva, a *Ceratium*, and a few living infusoria.

3. Some food sucked from the mouth by means of a pipette included detritus, diatoms, copepods (empty casings), some ostracods, one veliger larva, nauplius larvae, empty podiae of small crustaceans, a peridinean, and a few sponge spicules.

The following are analyses of samples of excrement from preserved specimens:

Metacrinus rotundus, Sagami Bay, Japan, 180 meters. The excrement was collected from the bottom of the vessel in which the animal had been laid. It consisted of detritus, diatoms, tissues of more highly organized plants, solitary crustacean podiae, crustaceans, and Foraminifera.

Comantheria grandicalyx, Bonin Islands, 54–72 meters. The sample was obtained in the same way as the preceding. It consisted of detritus, threads of algae, small grains of sand, diatoms, sponge spicules, bits of leaves (the largest 4.5 by 1.25 mm.), bryozoans, solitary holothurian anchors, a syllid (2.1 by 2 mm.) and a syllid larva, and a piece of a hydroid colony (length 5 mm., breadth of branches 0.15 mm.).

Comaster delicata grandis, Bonin Islands, 72 meters. The sample was taken directly from the intestine. It contained algal threads, numerous radiolarians, tintinnoids, crustacean podiae, solitary diatoms, grains of sand, Foraminifera, bits of bryozoans, and sponge spicules. In another sample from another specimen of the same species taken at the Bonin Islands in 144 meters the diatoms (*Planktoniella*, *Thalassiothrix*, and *Nitschia*) were more abundant; otherwise this sample was like the other.

Zygometra microdiscus, Broome, Western Australia, from the shore. The sample was taken from the anal opening. It contained grains of sand, diatoms, small copepods, ostracods, Foraminifera, and veliger larvae.

Tropiometra afra macrodiscus, Misaki, Sagami Bay, Japan, 2–3 meters. Two specimens were dissected. The intestine was almost empty. There were inconsiderable remains of grains of sand, crustacean podiae, and diatoms. In the gullet were large parasitic myzostomes.

Asterometra anthus, Bonin Islands, 180 meters. The sample was taken from the intestine and contained detritus, radiolarians, solitary bits of crustacean podiae, Foraminifera, and one *Ceratium*.

Heliometra glacialis, west of Spitzbergen (lat. 79°30′ N., long. 10°30′ E.), 100 meters. The sample was from the intestine and contained numerous copepods, solitary ostracods, polynoid bristles, and one tintinnoid.

Dr. Astrid Cleve-Euler identified the diatoms in some of the samples given above. A sample of the excrement of *Antedon petasus* contained *Actinocyclus crassus*, *Actinoptychus undulatus*, *Biddulphia aurita*, *Campylodiscus thuretii*, *Cerataulus smithii*, *Coscinodiscus excentricus*, *C. oculus iridis*, *C.* sp. (with large meshes), *Cocconeis scutellum*, *Diploneis nitescens*, *Grammatophora marina*, *Hyalodiscus scoticus*, *H. stelliger*, *Navicula cyprinus*, *Paralia sulcata*, *Nitschia longa*, *N. seriata*, *Rhabdonema arcuatum*, *R. minutum*, *Rhizosolenia setigera*, *Trachyneis aspera*, and the following Silicoflagellata: *Distephanes speculum* and *Ebria tripartita*.

The excrement of *Comantheria grandicalyx* contained *Achnanthes longipes*, *Amphora* sp., *Actinoptychus undulatus*, *Coscinodiscus* sp. (with large meshes), *Diploneis didyma*, *D. litoralis*, *Epithemis* (*Rhopalodia*) *gibba*, *Grunoviella marina*, *Grammatophora marina*, *Melosira nummuloides*, *Orthosira splendida*, *Paralia sulcata*, *Trachyneis aspera;* there were many sponge spicules and star-shaped hairs.

In the excrement of *Comaster delicata grandis* there were few diatoms, *Asterolampa marylandica* var. *major*, *Nitschia marina*, *Navicula lyra*, all solitary, the silicoflagellate *Dictyocha fibula*, and many radiolarians.

The excrement of *Metacrinus rotundus* contained *Achnanthes mammalis*, *Actinocyclus ehrenbergi*, *Actinoptychus undulatus*, *Amphora costata*, *A. macilenta*, *Climacospnenia elongata*, *Cocconeis reticulata*, *C. dirupta*, *C. finmarchica*, *C. pellucida*, *Coscinodiscus radiatus*, *C. excentricus*, *C. curvatulus*, *C. oculus iridis*, *Cyclotella striata*, *Diploneis* sp., *Grammatophora oceanica* var. *macilenta*, *G. angulosa* var., *Isthmia nervosa* fragments, *Navicula libellus, Nitschia panduriformis* var. *minor, Synedria affinis, Trachyneis aspera, Thalassiosira gelatinosa,* and *Thalassiothrix nitschioides.*

Mrs. Cleve-Euler's opinion on the diatoms identified was that the major part of the species represented are of benthonic origin. The species of *Cocconeis* are epiphytes on algae and similar material. Some of the others, as *Actinocyclus, Actinoptychus, Coscinodiscus, Cyclotella, Hyalodiscus stelliger,* and *Paralia,* are tychopelagic (=semipelagic), mostly heavy types that keep to deeper water. *Thalassiothrix* is pelagic. Mrs. Cleve-Euler was unable to find any pronouncedly pelagic genus, such as *Chaetoceras,* in either of the first two samples. She said of the last two, "Possibly setae of true pelagic plankton types, such as *Chaetoceras,* are present, but they could not be determined," and added, "It does not seem probable that they [true pelagic forms] are devoured to any extent worth mentioning by these animals."

Basing his opinion on the evidence afforded by the samples of excrement, and in the light of Mrs. Cleve-Euler's statements, Gislén considered it clearly manifest that the crinoids live upon a mixed diet of detritus, benthonic microorganisms, and plankton, but that the detritus plays a very important part, at least for some of them.

FORMATION OF THE AMBULACRAL GROOVE AND FEEDING IN THE COMASTERIDS

Gislén noted that the ambulacral groove is very variable in its formation and offers a great deal that is interesting if one follows its varying extension along the arms and pinnules.

The ambulacral groove originally extended to all the arms and appeared on all the pinnules. This primitive condition is still found in the stalked crinoids, for instance in *Metacrinus* and *Rhizocrinus.* In the comatulids, however, a varying number of proximal pinnules have developed into tactile organs and have been transformed into the so-called oral pinnules, which have no ambulacral groove or gonad. In most of the Bathymetrinae there is only one pair of these on each arm, *Antedon petasus* has two pairs, and *A. mediterranea* three. Simultaneously with the change of function their appearance also changes, and they generally become long, flagellate, and exceedingly flexible. They are very inconsiderably transformed in the Himerometridae, Stephanometridae, Charitometridae, and Thalassometridae, while a number of the Mariametridae, Calometridae, and Colobometridae, and most of the Macrophreata and Comasteridae show very advanced specialization.

Gislén said another reason why the extension of the ambulacral grooves differs from the usual type on certain pinnules is found in the development of the gonads. In most of the comatulids the first gonad appears on the first postoral pinnule, and they appear on all the pinnules following until far out on the arms. In the distal pinnules the gonads are not so strongly developed, and they gradually become partly, or completely, obliterated. In certain types, however, the gonads are restricted to certain pinnules, the genital pinnules, and in correlation with their exclusive function as egg or sperm producers, these have their ambulacral groove and their hyrococle more or less strongly reduced and become stout and clumsy. The distal pinnules, on the other hand, begin to play the role of respiratory organs and to become specialized for food collecting. They often become very much longer and more slender, and have their tentacles and ambulacral furrow very strongly developed. Thus at least certain species of the family Tropiometridae have no ambulacral groove on the first 8–12 pairs of pinnules, which are developed as genital pinnules. Similarly two representatives of the family Charitometridae, *Poecilometra acoela* and *Pachylometra angusticalyx*, sometimes lack the ambulacral groove on as many as 20 pairs of proximal pinnules, and Gislén found that in *Diodontometra* the first 9 pairs of pinnules, which have become transformed into broad joints protecting the gonads, have no ambulacral groove.

In all these cases the reduction of the ambulacral groove is the same on all the arms. The comasterids, which show far reaching reduction in the apparatus for obtaining food, have gone in another direction. Gislén said that these animals are in a state of transition—from a radial type they are changing to a pronouncedly bilateral type. The mouth moves forward in the anterior radius, or toward the right anterior interradius, and often takes a marginal position on the disk. The anal funnel assumes the central position of the mouth, in consequence of a lengthening of the intestine. The anterior arms lengthen and their pinnules become long and slender, like the distal pinnules of *Tropiometra*. The posterior (aboral) arms are shortened and have limited longitudinal growth. They become thicker, stouter, and clumsier, according to Gislén perhaps, though not very likely, on account of the abundant formation of sex products in them. A cooperating factor in the enlargement of the joints is certainly to be found in the strengthened muscular and ligamentary connections between the brachials. As a result of this division of labor between the anterior and posterior arms the ambulacral furrows lose their radially symmetrical arrangement and are often present on the anterior radii only. It is to be observed that the ambulacral furrow really disappears, and is not found remaining "in a closed groove."

Great variation prevails even in the same species. In a number of 10-armed specimens of *Comatula pectinata* and its variety *purpurea* from Cape Jaubert, Western Australia, there is no ambulacral furrow on from none to four of the posterior arms; in a *Comanthus parvicirra* from Sagami Bay, Japan, out of 33 arms 13 in the posterior radii had no ambulacral groove, while 4 neighboring arms had it developed distally of the fifteenth or twentieth pair of pinnules.

Gislén remarked that the reduction of the ambulacral grooves goes so far in the Comasteridae that one is tempted to ask whether the apparatus for gathering food can really be sufficiently large to collect nourishment enough for these relatively stout and clumsy animals.

In order to form an opinion of the relations existing between the apparatus for collecting food and the size of the animal Gislén estimated the total length of the ambulacral groove, measured the volume of the animal, and then by comparing the figures determined their relation to each other.

The total length of the ambulacral grooves was obtained by measuring the length of the arms, multiplying by their number, and to the figure thus obtained adding the product of the number of pinnules per arm, the average length of the pinnules, and the number of arms. The final figure gives the approximate length of the ambulacral grooves.

Among the crinoids measured by Gislén *Rhizocrinus lofotensis*, which has only four or five pairs of pinnules per arm, gave the lowest total figure. The length of the ambulacral grooves in a 6-armed specimen was only 0.14–0.22 meters. Among the comatulids measured a specimen of *Comissia ignota minuta* with 10 arms 20 mm. long showed the shortest ambulacral grooves, 1.30 meters. It is about the same length in a specimen of *Compsometra parviflora* with 10 arms 25 mm. long, in which the grooves measure 1.37 meters. It is only inconsiderably longer in a specimen of *Pentametrocrinus diomedeae* with 5 arms 55 mm. long (1.85 meters) and in a specimen of *Thaumatometra comaster* with 10 arms 45 mm. long (2.98 meters). *Oligometra chinensis* with 10 arms 55 mm. long has the ambulacral furrows 7.15 meters in length, while a large *Antedon petasus* with the 10 arms 110 mm. long has them 16.28 meters long. A specimen of *Stephanometra spicata* with 26 arms 130 mm. long has the ambulacral grooves 38.48 meters long; a specimen of *Liparometra grandis* with 26 arms 120 mm. long has them 44.72 meters long; a specimen of *Heliometra glacialis* with the 10 arms 200 mm. long has them 54.5 meters long; and in a specimen of the multibrachiate *Himerometra magnipinna* with 49 arms 90 mm. long they reach 61.23 meters in length. A large individual of *Metacrinus rotundus* with 56 arms 210 mm. in length from the radials has the ambulacral furrows 71.68 meters long. The highest numbers, however, are found in the Comasteridae, a specimen of *Comantheria grandicalyx* with 68 arms 125 mm. long having the ambulacral furrows 102.68 meters in length.

Gislén mentioned a few facts that it seemed to him might influence the relative length of the ambulacral furrow. At great depths the food supply is more scanty than higher up, partly because the bottom life is not so abundant, and partly because the plankton does not rain down so plentifully, whereas in the littoral zone the food is very abundant. Deep-sea forms ought therefore to have a relatively long ambulacral groove in proportion to their size, while shallow water forms ought to be able to manage with a shorter one. The degree of calcification probably plays some part also. A strongly calcified animal has relatively less organic substance than one which is inconsiderably calcified. The former has less substance to support, and ought to be able to obtain the necessary amount of nourishment with a proportionately shorter ambulacral furrow.

Two objects of similar shape but differing in size stand in relation to each other as the square of the surface and the cube of the volume. If we take a 10-armed comatulid of a certain size and compare it with a similar but much smaller one the lesser one ought to have a relatively greater surface in proportion to the volume; or if we compare it with a larger one, the larger one in proportion to the volume ought to have a smaller surface. The figure represented by the total length of the ambulacral groove is a function of the surface supplying nourishment and varies with it. The ratio between the ambulacral grooves and the volume in very small comatulids gives an abnormally high figure, and in very large comatulids an abnormally low one.

The following figures show the relationship between the length of the ambulacral furrows and the bulk in various comatulids.

Comissia parvula, Sagami Bay, Japan, 720 meters (10 arms 35 mm. long): Length of ambulacral furrows, 1.95 meters; weight 0.89 grams; volume 0.74 cc.; specific weight 1.20; length of ambulacral furrows divided by volume 2.64.

Comatula pectinata, Cape Jaubert, Western Australia, 20 meters (10 arms, 6 grooved, 90 mm. long): Length of ambulacral furrows 4.37 meters; weight 4.83 grams; volume 3.46 cc.; specific weight 1.39; length of ambulacral furrows divided by volume 1.26.

Comantheria grandicalyx, Bonin Islands, 54–72 meters (68 arms 125 mm. long): Length of ambulacral furrows 102.68 meters; weight 89.6 grams; volume 73.6 cc.; specific weight 1.22; length of ambulacral furrows divided by volume 1.39.

Comaster delicata grandis, Bonin Islands, 72 meters (46 arms 115 mm. long): Length of ambulacral furrows 58.92 meters; weight 39.1 grams; volume 30.0 cc.; specific weight 1.30; length of ambulacral furrows divided by volume 1.96.

Comanthus parvicirra, Misaki, Japan, 0–3 meters (33 arms, 20 grooved, 50 mm. long): Length of ambulacral furrows 7.16 meters; weight 6.65 grams; volume 5.40 cc.; specific weight 1.23; length of ambulacral furrows divided by volume 1.33.

Catoptometra magnifica minor, Kiu Shiu, Japan, 900 meters (27 arms 95 mm. long): Length of ambulacral furrows 34.50 meters; weight 6.70 grams; volume 5.42 cc.; specific weight 1.24; length of ambulacral furrows divided by volume 6.37.

Eudiocrinus loveni, Bonin Islands, 144 meters (5 arms 43 mm. long): Length of ambulacral furrows 2.47 meters; weight 0.65 grams; volume 0.47 cc.; specific weight 1.38; length of ambulacral furrows divided by volume 5.26.

Heterometra crenulata, Cape Jaubert, Western Australia, 21 meters (30 arms 75 mm. long): Length of ambulacral furrows 43.05 meters; weight 11.55 grams; volume 8.28 cc.; specific weight 1.39; length of ambulacral furrows divided by volume 5.20.

Lamprometra palmata, Trincomalee, Ceylon, 7 meters (43 arms 50 mm. long): Length of ambulacral furrows 23.44 meters; weight 7.15 grams; volume 5.75 cc.; specific weight 1.24; length of ambulacral furrows divided by volume 4.08.

Cyllometra pulchella (=*manca*), Kiu Shiu, Japan, about 200 meters (14 arms 40 mm. long): Length of ambulacral furrows 6.02 meters; weight 0.72 grams; volume 0.60 cc.; specific weight 1.20; length of ambulacral furrows divided by volume 10.02.

Tropiometra afra macrodiscus, Misaki, Japan, 0–3 meters (10 arms 255 mm. long): Length of ambulacral furrows 47.69 meters; weight 39.8 grams; volume 34.4 cc.; specific weight 1.16; length of ambulacral furrows divided by volume 1.39.

Asterometra anthus, Bonin Islands, 207 meters (10 arms 70 mm. long): Length of ambulacral furrows 10.60 meters; weight 3.12 grams; volume 2.34 cc.; specific weight 1.33; length of ambulacral furrows divided by volume 4.52.

Pectinometra flavopurpurea, Sagami Bay, Japan, 720 meters (20 arms 80 mm. long): Length of ambulacral furrows 17.84 meters; weight 4.60 grams; volume 3.55 cc.; specific weight 1.30; length of ambulacral furrows divided by volume 5.02.

Perissometra aranea, Kiu Shiu, Japan, 198 meters (11 arms 100 mm. long): Length of ambulacral furrows 7.04 meters; weight 1.93 grams; volume 1.46 cc.; specific weight 1.32; length of ambulacral furrows divided by volume 4.83.

Antedon petasus, Kristineberg, Sweden, 30–40 meters (10 arms 110 mm. long): Length of ambulacral furrows 16.28 meters; weight 2.63 grams; volume 2.29 cc.; specific weight 1.15; length of ambulacral furrows divided by volume 7.10.

Heliometra glacialis, East Greenland, 80–100 meters (10 arms 200 mm. long): Length of ambulacral furrows 54.5 meters; weight 50.0 grams; volume 45.0 cc.; specific weight 1.11; length of ambulacral furrows divided by volume 1.21.

Gislén said that a glance at these figures shows at once that in the ratio between the length of the ambulacral groove and the volume the average is much smaller in the Comasteridae than in the other comatulids—about 1.7 as against 5.0.

Comissia parvula shows for a comasterid an abnormally high figure, partly because it is a small species, partly because it is endocyclic, and partly because it is a deep-sea species. For the last-mentioned reason the figure for *Catoptometra magnifica minor* is also unusually high. *Lamprometra palmata* is a littoral type and therefore shows a low figure. Species having a high specific weight, that is, strongly calcified species, usually show low figures also. In *Pectinometra flavopurpurea* the decrease is counterbalanced by the great depth at which the animal is found. On the other hand, the slightly calcified *Antedon petasus* and *Cyllometra pulchella*—the latter also very small—show very high figures.

Gislén said it is more difficult to explain the deviation in *Tropiometra afra macrodiscus* and *Heliometra glacialis.* Both are, however, exceptionally large types, and the former is at the same time a littoral species. The body of *Heliometra glacialis* is not very strongly calcified, which should perhaps counterbalance its gigantic size, and so also should the fact that it is not a littoral form.

An analysis of the intestinal contents of *Heliometra glacialis* showed a great abundance of copepods, these being present almost exclusively—very nourishing food. This comatulid lives outside the great glaciers of Spitsbergen and Greenland, where an abundance of plankton is found. Gislén suggests that possibly this may explain to some degree the low figure. The appearance of "rudimentary combs" on the proximal pinnules must, however, be noticed.

Gislén noted that he had chosen for his investigations the most divergent types from the most diverse localities he was able to obtain, and he said that therefore one should not feel too much surprised if a few divergencies from the general rule appear. It is possible that in the two cases of great divergency described some unknown facts may play a part. Taken as a whole, however, it seemed to Gislén that the difference between the low figure of the Comasteridae and the high figure for the rest of the comatulids is very remarkable. It is all the more noticeable that the figures given for the Comasteridae are low throughout, as three of the five comasterids examined have ambulacral furrows on all the arms and most of the pinnules.

FORMATION AND CONTENTS OF THE INTESTINE IN THE COMASTERIDAE

Gislén noted that although in the Comasteridae the ambulacral grooves are abnormally short in proportion to the size of the animals, the great length of the intestine suggests that the food is richer and at the same time more difficult to digest. He said that the author's explanation of the elongated digestive tube in the Comasteridae (Part 1, p. 343, fourth paragraph) is only in part correct. Certainly the Comasteridae in general are shallow-water types, particularly the exocyclic ones; but so also are certain families with central mouths, as the Himerometridae, Mariametridae, Stephanometridae, and Tropiometridae. That the Comasteridae are confined to muddy bottoms is not correct, as may be seen by an examination of the localities given in the *Siboga* report. Comasterids were collected at 65 localities at which the character of the bottom was recorded; of these localities 54 also yielded exocyclic comatulids. In 41 of these localities they were taken from a bottom consisting of stone, sand, "coral," and *Lithothamnion;* mud was found in only three cases. Gislén's examination of the intestinal contents in the Comasteridae showed that the vegetable food is certainly very plentiful, consisting for the most part of Chlorophyceae, but that inorganic matter is inconsiderable or wholly absent.

MORPHOLOGY OF THE COMBS AND THEIR BIOLOGICAL FUNCTION

Gislén noted that the Comasteridae differ from all the other comatulids except the Heliometrinae in the possession of the so-called combs, which usually appear on the proximal pinnules but sometimes are found far out on the distal parts of the arm in *Comaster* and in occasional species [or individuals] of *Comanthus* (*Vania*), *Comanthina*, and *Capillaster*. In the Heliometrinae rudimentary or fairly well developed combs appear on one or more of the proximal pinnules. The genus *Comatonia* (see Part 3, page 288) is supposed by Gislén to belong to this subfamily of the Antedonidae. It has been observed (see Part 2, page 95, fourth paragraph) that in *Heliometra glacialis* the terminal segments of the arms and pinnules are devoid of ambulacral grooves. Gislén points out that we thus find the remarkable coincidence that in a group not belonging to the Comasteridae, in which the ambulacral furrows are unusually short, combs reappear, and that a change sets in suggesting a reduction of the ambulacral furrows. He recalled that the intestinal contents in *Heliometra* show remarkable differences from those of the rest of the comatulids catching plankton or detritus.

The combs are developed at the ends of the pinnules. Only occasionally, as in *Comantheria* or *Comanthus*, are the most distal segments of the combed pinnules smooth. In *Comatonia* teeth appear on P_1 and P_a almost from their bases. The teeth are usually developed on one side only, and are ranged in a single row on the side away from the mouth. In *Nemaster*, *Comanthina*, and *Comanthus* two rows of teeth occur, an inner row of large teeth, and an outer row of small ones.

Transverse sections through the proximal combed pinnules and the distal pinnules of *Comantheria delicata grandis* show that, at least in this form, a small interior tooth occurs inside the large exterior tooth, as in *Nemaster*, etc., although it is not discernible to the naked eye. The sections make it evident that these teeth are derived from the dorsal hooks that occur in most of the comatulids and are especially well developed in the Comasteridae; these have increased in size and have made their way up on one side of the pinnule. Usually on a pinnule that has not been transformed three dorsal hooks stand in a transverse row on the distal segments. When enlarged to form a comb the hook situated most adorally gains the preponderance and surpasses the others, which become more or less suppressed, in size. In regard to its combs *Nemaster* shows its primitive character in the occurrence of two rows of teeth in the comb. The inner row is less evident in the more specialized genus *Comaster*, although quite distinct in sections. In *Comanthus pinguis*, in which the comb shows a presumably secondary tendency to reduction, the inner row of teeth is very indistinct.

In contrast to the distal ends of the other pinnules, those of the combed pinnules may be rolled into a tight spiral, as one of the interpinnular muscles, always the aboral, is very strongly developed. This muscle continues through a large part of the segment, penetrating deeper on the proximal side than on the distal, and so locating the thin dividing wall between the muscles of the articulations somewhat distally of the center of the ossicles. As a consequence of this exceedingly one sided muscular development, the muscular side of the pinnule is much enlarged. The intruding hypertrophied muscle has pressed the dorsal coelome toward the adoral side. Presumably migration of the dorsal hooks toward the aboral side is explained by the stronger calcification and development of the side turned away from the mouth.

Gislén said that I endeavored to explain the biological function of the combs by assuming that they pick away foreign particles from the arms and pinnules, especially parasitic myzostomes. But he pointed out that the Comasteridae are almost more abundantly provided with these than any other family. He himself found an entoparasitic ?*Protomyzostomum* on *Comantheria delicata grandis*, and ectoparasitic myzostomes on *Comanthus pinguis* and *Comissia parvula*. So he did not think the function of the combs could to any essential extent be the one given by the author. The different species of myzostomes are in general each confined to its own particular comatulid or to a few species. If the principal task of the combs had been to free the animal from parasitic myzostomes, either these parasites would soon have been rooted out in the Comasteridae, or they would have to become endoparasitic to escape the combs. According to Gislén, in either case the combs as organs for exterminating myzostomes would have become superfluous at about the same time as they appeared. He said that according to this theory it is difficult to understand why certain genera should acquire combs far out on the distal pinnules, for the myzostomes practically always occur on the disk, or on the arms in its immediate neighborhood. For the particles of food become more and more concentrated toward the mouth. Still, Gislén said, there is a possibility that in certain forms the combs have a general cleansing function.

Gislén maintained that the dorsal hooks in comasterids with reduced cirri act as anchoring organs offsetting the loss of the cirri. He noted that this seems to be the case also with the grooveless pinnules in *Comatulella brachiolata* and remarked that in these the coiling takes place more toward the laterodistal side than toward the dorsal side. He found this theory supported partly by the occurrence of the dorsal hooks, so generally and exceptionally strongly developed in the Comasteridae, and partly by the reduction and disappearance of the cirri in certain species. In *Comanthus pinguis* the cirri are strong and the dorsal hooks weak, and in *Comanthus timorensis* the conditions are reversed.

His idea of the development of the teeth of the combs from the dorsal hooks is as follows: Originally all the distal segments of the pinnules possessed small dorsal hooks. Dorsal hooks appear in a more or less rudimentary form on the outermost segments of the more distal pinnules in most of the comatulids. On the other hand, the oral pinnules are smooth distally except in the subfamily Heliometrinae of the family Antedonidae.

The combs must be considered to have appeared first on the oral pinnules. In forms in which the combs extend far out on the distal pinnules this feature appears only at an ontogenetically very late stage.

The oral pinnules in most of the comatulids are developed into tactile organs and are very sensitive. In a number of forms, thanks to short segments, they are also exceedingly flexible. Because of the formation of the facets of the segments this flexibility can function only in a lateral direction. Thanks to the dorsal hooks and the great flexibility of the oral pinnules, the latter were able to catch hold of objects falling upon the disk or outside the ambulacral grooves that were too large to be carried away by the ciliary currents. In order to do this, the pinnule tip has been greatly contracted aborally.

Between the usual distal pinnule segments the transversely striated muscle bundles are very small, almost rudimentary, and the greater part of the facets of the segments is occupied by the ligamentary connections. This structure does not permit more than rather weak and slow contraction. Between the pinnule segments in the region of the combs, on the other hand, the transversely striated muscle bundles, especially those of the aboral part, are enormously developed, which allows of strong and rapid contraction. Gislén believes that the aboral muscle, by stronger growth gradually forced the weaker aboral muscle toward the side and thus secured a more medioventral position for itself. Owing to this the pinnule tip was no longer able to curve in laterally when contracted, but was rolled up ventrally, and the comb must, in order not to lose its effect, proceed up the aboral side of the pinnule. Gislén said that in this way we may explain the greatly one-sided strengthening of the muscles, the torsion of the pinnule tip (twisted at right angles to the longitudinal direction), and the progress of the dorsal spines up the lateral side turned from the mouth.

In the Comasteridae, as pointed out by Gislén, branches from the dorsal nerve run to the bases of the teeth, and these may possibly be of some importance in connection with the senses of touch or of taste. As a consequence of the rich innervation the pinnule tip should be able to determine whether an object seized is edible or inedible. It is often difficult to draw a sharp line between the ciliary currents for cleansing purposes and those carrying food. Here, too, the possibility of an alternation of function may easily be presumed. When the combs have once begun to grasp small particles that have fallen upon the animal, it may easily be imagined that instead of letting the object drop down between the arms they may put it into the ambulacral groove or into the mouth. From this it is not a very long step to begin picking up or pinching off small particles—algal threads, bits of bryozoans, pieces of leaves, etc.—which do not fall directly down upon the animal, but which are found in its immediate neighborhood. In this way, according to Gislén, the formation of the combs upon the oral pinnules may be explained.

The dorsal hooks on the distal pinnules were used as anchoring organs. These would sometimes catch hold of some soft loose object from which small pieces could be severed. By curving in the tip of the pinnule over the ambulacral groove of the arm or of the pinnule itself the combs were able to pass on the particles of food to the ciliary current to be transported to the mouth. In this way a torsion must also have been developed in the formation of the pinnule, owing to the one sided development of the muscles. The combs upon the distal pinnules might have arisen in this way. The animal by means of these structures was supplied with an extra (and more heavily digested) contribution of food, the intestine therefore becoming lengthened and the ambulacral grooves reduced as being unnecessary.

In certain comasterids, as in the species of *Comissia*, *Comatilia*, and some forms of *Comactinia echinoptera*, the combs are limited to one or two pairs of the proximal pinnules. These forms are endocyclic, except possibly one form of *Comactinia echinoptera*. Gislén believes that in these and other endocyclic comasterids the combs are of predominating importance for cleansing and anchoring purposes.

In a specimen of the almost perfectly endocyclic *Comaster novaeguineae* with 67 fully developed and 9 short regenerating arms averaging 63 mm. in length the weight was 11.6 grams and the volume 8.25 cc. If all the arms and pinnules had possessed functional ambulacral grooves the total length of these grooves would have been 38.1 meters. The ratio between the ambulacral grooves and the volume would have been 4.6. But the two posterior radii bearing 34 arms show only a rudimentary ambulacral furrow on the arms, while a large number of the pinnules have no ambulacral grooves. The animal's effective ambulacral grooves are therefore probably at most not more than from 25 to 30 meters long, the ratio thus being between 3.0 and 3.6—unusually small for an ordinary comatulid, but unusually large for a comasterid.

Most of the comasterids are exocyclic. The most advanced types, as *Comaster*, *Vania*, and *Capillaster*, have combs even upon some of the distal pinnules, and are in most cases exocyclic, except various very slender species of *Comaster*, as *C. minimus*, *C. novaeguineae*, and *C. sibogae*. Among these, too, the combs are most likely of importance for gathering food. The combs appear in the *Comaster* type upon every other, or every third, pinnule. About half the genital pinnules are provided with combs. As a result of the development of sex products these pinnules are greatly swollen, clumsy, and presumably not very flexible. It is easy to imagine that this somewhat impedes the combs when engaged in passing the collected food to the ambulacral groove, and that instead it is probably easier to pass the food from one comb to another along the arm toward the mouth. As the combs occur on the arms with no ambulacral groove as well as on the others, an explanation of this sort becomes a necessity, if the combs are to be regarded as of any importance in supplying food. In a specimen of *Comanthus parvicirra* form *vaniipinna* the most distal combed pinnule on a grooveless arm was 7 mm. long, while the distance to the nearest ambulacral groove was 18 mm.

Gislén said there is an interesting parallel here to the similar method of obtaining food found in the ophiurans. The evolutionary plan, however, is realized in two different ways in the two cases. In the ophiurans it is the tube-feet, the equivalent of the tentacles of the crinoids, that take over the transportation of food to the mouth. The ambulacral groove, which orginally was undoubtedly ciliated, and used for transporting food to the mouth, became unnecessary and was closed by the margins growing together, finally coming to lie in the epineural canal. Ontogenetical evidence of this, according to Gislén, is found in the ambulacral groove still being open in very young individuals. In the Comasteridae it is the combs—the transformed dorsal hooks on the ends of the pinnules—that have begun to take over the transportation of nourishment. The process of evolution has not gone so far here, but there is an evident tendency toward the elimination of the ambulacral furrow. The process, however, takes place in a way different from that seen in the ophiurans. The epithelium of the ambulacral groove degenerates so that the difference between it and the surrounding epithelium disappears. In both cases there results a nonciliated arm. In the ophiurans the ciliary groove becomes enclosed in an epineural canal and is retained as a cord, now exclusively nervous, while in the comasterids the ambulacral folds are smoothed out and the ambulacral groove obliterated, the complete disappearance in this case evidently being possible because there are already nervous systems developed in the arms.

DETAILS OF ARM STRUCTURE

In his report upon a mass of dissociated comatulid ossicles from the Eocene (Middle Jacksonian) at Baldock, Barnwell County, S. C., Professor Gislén took occasion to classify the types of arm ramification found in the comatulids, both recent and fossil. He distinguished 85 types, which he analyzed in detail on the basis of available data taken from previously recorded specimens. He also reviewed with great care such of the structural features of the Himerometridae as would be of importance in the determination of dissociated fragments.

From these dissociated ossicles he reconstructed *Himerometra bassleri*, sp. nov., most closely related to the recent *H. persica*, which is interesting in being the only representative of the family Himerometridae that has been found in America.

From the same material he also segregated fragments that he referred to *Microcrinus* cf. *conoideus* Emmons and to *Glenotremites* (*Paleantedon*) *carolinianus*, sp. nov.

TYPES OF ARM BRANCHING IN THE COMATULIDS

Dr. Gislén has divided the arm branching in the comatulids into 85 types, which are (omitting those found only in fossil forms) as follows:

(2) *Eudiocrinus* type (*Eudiocrinus* only). (3) *Pentametrocrinus* type (*Pentametrocrinus* and *Atopocrinus*). (4) *Thaumatocrinus* type (same as the preceding, but with 10 radials). (7) *Comatula pectinata* type (10-armed species of *Comatula*, and *Comatulella*). (8) *Zygometra pristina* type (*Zygometra pristina* and 10-armed young of *Zygometra* and *Catoptometra*). (9) *Antedon* type (the majority of comatulids). (10) *Monachometra fragilis* type I. (11) *Promachocrinus* type (*Promachocrinus* only). (15) *Comatula rotalaria* type (*Comatula rotalaria* only). (16) *Comatella maculata* type. (17) *Neocomatella pulchella* type I. (18) *Neocomatella alata* type. (19) *Comatella brachycirra* type. (20) *Asterometra* type. (21) *Stenometra diadema* type. (22) *Monachometra fragilis* type II. (23) *Diodontometra* type. (25) *Catoptometra rubroflava* type. (26) *Catoptometra hartlaubi* type I. (27) *Perissometra macilenta* type. (28) *Pachylometra angusticalyx* type. (29) *Heterometra bengalensis* type. (30) *Comanthus solaster* type. (31) *Adelometra angustiradia* type. (32) *Crinometra imbricata* type. (32a) The abnormal *Comanthoides spanoschistum* type. (33) *Capillaster coccodistoma* type. (34) *Nemaster discoidea* type. (35) *Heterometra compta* type. (37) *Comatella stelligera* type. (38) *Catoptometra magnifica minor* type. (39) *Neocomatella pulchella* type II. (40) *Crinometra concinna* type. (41) *Stylometra spinifera* type. (42) *Stephanometra spicata* type. (43) *Mariametra subcarinata* type. (44) *Comanthus parvicirra* type I. (45) *Comaster serrata* type. (46) *Crossometra septentrionalis* type. (47) *Zygometra comata* type. (48) *Heterometra crenulata* type. (49) *Comantheria rotula* type. (50) *Oceanometra magna* type. (51) *Comanthus japonica* type. (52) *Comanthus timorensis* type I. (53) *Himerometra martensi* type. (54) *Crinometra transversa* type. (55) *Catoptometra hartlaubi* type II. (56) *Comanthus parvicirra* type II. (57) *Comanthus timorensis* type II. (58) *Crinometra insculpta* type. (59) *Heterometra nematodon* type. (60) The irregular *Comanthus timorensis* type III. (61) *Nemaster grandis* type. (62) *Capillaster multiradiata* type. (63) *Capillaster macrobrachius* type. (64) *Capillaster mariae* type. (65) *Comaster gracilis* type I. (66) *Comatella nigra* type. (67) *Catoptometra magnifica* type. (68) *Oxymetra crinacea* type. (69) *Pontiometra andersoni* type. (70) *Coman-*

thus timorensis type IV. (71) *Comaster gracilis* type II. (72) *Comaster multibrachiata* type. (73) *Comantheria delicata* type. (74) *Zygometra microdiscus* type I. (75) *Comanthus pinguis* type. (76) *Comanthus bennetti* type. (77) *Comantheria polycnemis* type. (78) *Comantheria intermedia* type. (79) *Comantheria alternans* type. (80) *Comanthina belli* type. (81) *Zygometra microdiscus* (*elegans*) type II. (82) *Comantheria briareus* type. (83) *Himerometra magnipinna* type. (84) *Comanthina schlegelii* type. (85) *Capillaster sentosa* type.

EXTENT OF THE DISK

Gislén says that the disk in *Clarkometra elegans* reaches to brachials 3+4; in *Tropiometra afra macrodiscus* and in *Antedon petasus* to brachials 4 or 5; in *Leptonemaster venustus* to brachial 5; in *Promachocrinus* to brachial 6; in *Notocrinus* to brachial 7; in *Pentametrocrinus diomedeae* to brachials (5–) 8; in *Heterometra crenulata* and *Amphimetra jacquinoti* to brachial 6; in *Heliometra* and *Anthometra* to brachials 7–8; in *Atopocrinus* to brachial 9; in *Comanthus pinguis* only to the second or fourth element in the IIIBr series; and in *Comaster novaeguineae* only to the third or fourth element in the IIBr series.

Order COMATULIDA A. H. Clark (continued)

The general account of this order, with the diagnosis, synonymy, range, and keys to the included families and higher groups, will be found in Part 3, pp. 69–74.

Suborder OLIGOPHREATA A. H. Clark (continued)

The synonymy, diagnosis, range, and history of this suborder will be found in Part 3, pp. 74–76.

Superfamily MARIAMETRIDA Gislén

Mariametrida GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 230, 233, 235, 237, 240; Arkiv för Zool., vol. 19, No. 32, 1928, p. 4.—A. H. CLARK, Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 554; Treubia, vol. 14, livr. 2, 1933, p. 211.—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 7, 49.—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 88.—H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 42.

Diagnosis.—A superfamily of the suborder Oligophreata (see Part 3, p. 74) in which there is no comblike structure on the distal portion of the oral pinnules; the distal pinnules are never prismatic; the genital pinnules are never prismatic, though occasionally a few of the basal segments may be carinate; the oral pinnules, which may be long or short, slender or stout, or stout basally and slender distally, very flexible to stiff and spinelike, composed of long or short segments, usually show some distinct trace of carination on more or fewer of the basal segments, and are sometimes sharply prismatic throughout; and the mouth is always central or subcentral, the anal tube being more or less marginal. Sacculi are always present, though often in small numbers. The arms vary from 5 to 100 in number but are usually between 15 and 40, though not infrequently 10.

Remarks.—The superfamily Mariametrida as herein understood includes the families Zygometridae, Eudiocrinidae, Himerometridae, Mariametridae, and Colobometridae. In addition to these Gislén included also the family Tropiometridae, which seems to me to be quite out of place here, its prismatic pinnules, very broad division series and first two brachials, ambulacral deposits, and cirri indicating a rather close relationship to the Thalassometridae and Charitometridae.

The family Zygometridae as understood by Gislén included the genus *Eudiocrinus*, which is herein set apart as a distinct family. The family Stephanometridae, which was included in the Mariametrida by Gislén, is here merged with the Mariametridae.

Within the superfamily Mariametrida the families Zygometridae and Eudiocrinidae agree, but differ from the other families, in having a syzygy between the elements of the IBr series, and also in having a more or less completely plated disk, although adambulacral deposits in the perisome of the pinnules are much reduced or absent (see Part 2, p. 236). These two families together thus form a distinct group, including two rather strikingly different types, within the superfamily Mariametrida, this group contrasting rather sharply with the group including the very closely related Himerometridae, Mariametridae, and Colobometridae.

Comparisons.—The members of the superfamily Mariametrida are very easily distinguished from the species of the superfamily Comasterida (see Part 3, p. 76) by the complete absence of a comblike structure on the distal portion of the oral pinnules. In most cases they are also readily distinguished by the central or subcentral mouth; but it must be remembered that in several of the species in the Comasterida the mouth is always, sometimes, or occasionally central.

The species of Mariametrida are readily distinguished from the species in the superfamily Tropiometrida by the middle and distal pinnules, which in the species of Tropiometrida always show a prominent sharp dorsal carination that becomes very conspicuous under a low power when the pinnule is dried. Furthermore, the outer pinnules in the species of Tropiometrida almost invariably are provided with side-plates and covering plates (see Part 2, figures 819–823, p. 392; figures 831–848, p. 405), which are easily visible in dried pinnules under a hand lens. It should be remembered, however, that in the genus *Tropiometra* these are greatly reduced (see Part 2, fig. 797, p. 372) and are not visible under a hand lens.

From the species included in the suborder Macrophreata the species of Mariametrida are distinguished by the relatively robust and short-segmented distal pinnules in which the first two segments are not appreciably broadened; by the irregular and relatively wide spacing of the syzygies; by the presence of some trace of carination on at least the basal segments of the oral pinnules; by the more or less abrupt differentiation of one or more of the oral pinnules, which are not simply elongated; and by the stronger and less easily detached cirri.

Most of the species of Mariametrida have more than 10 arms, while in the Macrophreata very nearly all the included species have 10 arms only, though one has 20 owing to the occurrence of 10 instead of 5 radials, and in one or two there may be a few more than 10. The 10-armed species of Mariametrida may be distinguished from the species of Macrophreata by the enlarged proximal pinnules, which are either stout and composed of relatively short segments, or if slender are more or less obviously prismatic with a group of spines, or a conspicuous process, at the distal end of the dorsal ridge on each segment. In the 10-armed species of Mariametrida also the brachials are almost always shorter, and the cirri are stronger and far less likely to be detached from the centrodorsal. The very few species of Macrophreata in which the brachials are short have especially fragile cirri, and P_1 is composed of a great number of exceedingly short segments, looking more or less like a string of little beads.

Both the Mariametrida and the Macrophreata include genera containing 5-armed species. In the 5-armed species of Mariametrida (included in the genus *Eudiocrinus*) the arms are short, the oral pinnules are much enlarged and sharply prismatic, and the second pinnule is on the second ossicle beyond the first (which is on the second post-radial ossicle—see fig. 127, p. 79, of Part 2) instead of on the immediately succeeding ossicle as would be expected. In the 5-armed species of Macrophreata (included in the genera *Pentametrocrinus* and *Atopocrinus*) the arms are very long with greatly elongated brachials and exceedingly fragile, the proximal pinnules are either absent or do not differ appreciably from those succeeding, and there is no gap in the succession of pinnules.

In both the Mariametrida and the Macrophreata there are species in which one or more of the proximal pinnules, most commonly the first inner pinnule (P_a), are absent. Most of these species in the Mariametrida have 10 arms only. In the Mariametrida the species with deficient pinnulation are all included in the single family Colobometridae. They are very easily distinguished from all the species in the Macrophreata by having on the dorsal surface of the cirrus segments either a serrate transverse ridge, or two tubercles or spines situated side by side, or a transverse row of 3 or 4 spines or tubercles; the dorsal surface of the cirrus segments in the Macrophreata is either broadly or more or less sharply rounded, or else is carinate in the middorsal line.

As the great majority of the 10-armed species of Mariametrida belong to the family Colobometridae, in the case of doubtful 10-armed forms the dorsal surface of the cirrus segments should always be the first feature examined.

Family ZYGOMETRIDAE A. H. Clark

Series I of *Antedon* P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 94; Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 304.

Elegans group [of *Antedon*] P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 266; Journ. Linn. Soc. (Zool.), vol. 21, 1889, pp. 304, 307.—Hartlaub, Bull. Mus. Comp. Zool., vol. 27, 1895, p. 136 (discussion), p. 137 (structural position).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1907, pp. 127, 130 (descriptions of new species); Smithsonian Misc. Coll., vol. 50, 1907, p. 348 (the equivalent of *Zygometra*, gen. nov.).

Zygometridae A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (includes *Eudiocrinus* and *Zygometra*); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 210 (in key), p. 211 (includes *Zygometra;* range; not represented in the Hawaiian Islands), p. 212 (range of included genus), p. 276 (revised description; range; includes *Zygometra* and *Eudiocrinus*); vol. 35, 1908, p. 118, figs. 14, 15, p. 119, fig. 16 (arm structure); Amer. Nat., vol. 42, 1908, p. 541 (characteristic of Indo-Pacific-Japanese fauna), p. 722 (ecology), p. 725 (color); Geogr. Journ., vol. 32, 1908, p. 602 (characteristic of Indo-Pacific-Japauese region), p. 605 (ecology); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 2 (modification of cirri and lower pinnules as in the Thalassometridae); Amer. Nat., vol. 43, 1909, p. 256 (absence from the Red Sea noteworthy); Proc. U. S. Nat. Mus., vol. 36, 1909, p. 361 (part of *Antedon* as used by P. H. Carpenter); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 174 (only family witn a syzygy in the IBr series; referred to Comatulida Oligophreata); Amer. Nat., vol. 43, 1909, p. 581 (arm structure); Vid. Medd. Nat. Foren. København, 1909, p. 119 (occurs at Singapore; has large eggs that presumably develop rapidly; ecology); Amer. Journ. Sci., vol. 29, 1909, p. 43 (articular facet of a radial, showing development); Proc. U. S. Nat. Mus., vol. 39, 1911, p. 538 (articulation between elements of IBr series really a remarkably perfect pseudosyzygy, as demonstrated by *Zygometra pristina*, sp. uov); vol. 40, 1911, p. 649 (referred to Oligophreata); Die Fauna Südwest Australiens, vol. 3, Lief. 13, 1911, p. 438 (1 genus and 3 species in Australia); Mem. Australian Mus., vol. 4, 1911, p. 717 (proportion of the species of this family in the fauna of Australia as known to P. H. Carpenter), p. 720 (proportion of the species of this genus in the Australian fauna), p. 725 (*Eudiocrinus* and *Catoptometra* absent from Australia; this family disproportionately developed in Australia), p. 728 (closely related to the Himerometridae), p. 729 (in key), p. 731 (1 genus in Australia); Crinoids of the Indian Ocean, 1912, p. 3 (*Hyponome sarsii* the detached visceral mass of some species of this family), p. 6 (confined to the East Indian region; number of included genera and species), p. 11 (occurs west to the west coast of the Malay Peninsula and the Andamans), p. 14 (very restricted distribution; littoral), p. 21 (distribution in detail), p. 42 (closely related to the Himerometridae), pp. 44, 45, 47, 48, 50, 52 (in keys), p. 56 (key to the included genera); Die Fauna Südwest Australiens, vol. 4, Lief. 6, 1913, p. 311 (discussion and comparison with the Himerometridae).—SPRINGER and CLARK, Zittel-Eastman's Paleontology, 1913, p. 236 (in Oligophreata).—A. H. CLARK, Bull. Inst. Océanogr., Monaco, No. 294, 1914, pp. 7, 8 (relation to temperature); Journ. Washington Acad. Sci., vol. 4, 1914, pp. 559–563 (correlation of geographic and bathymetrical ranges), p. 582 (relation to temperature).—ALEXANDER, Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 108.—A. H. CLARK, Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 114 (species collected by the *Endeavour* in Western Australia); Journ. Washington Acad. Sci., vol. 5, 1915, pp. 126–134 (bathymetric range; phylogenetic and paleontological significance); Amer. Journ. Sci., vol. 40, 1915, p. 63 (recent genera with fossil representatives, number of included species, recent and fossil, and their geological, geographical, bathymetrical and thermal ranges), p. 67 (detailed discussion of the bathymetrical range); Int. Rev. gesamt. Hydrobiol. und Hydrogr., 1915, p. 224 ff. (detailed account of the distribution of Australian species); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, p. 25 ff. (phylogenetic study).—H. L. CLARK, Biol. Results Fishing Exper. F. I. S. *Endeavour*, 1909–14, vol. 4, pt. 1, 1916, p. 21 (*Oreometra* a connecting link between this family and the Calometridae, if not actually a member of the Zygometridae).—A. H. CLARK, Unstalked crinoids of the *Siboga* Exped., 1918, p. 59 (discussion of genera and species).—GISLÉN, Kungl. Svenska Vet. Akad. Handl., vol. 59, No. 4, 1919, p. 19.—A. H. CLARK, Univ. Iowa Studies in Nat Hist., vol. 9, No. 5, 1921, p. 13 (includes fossil and recent species), p. 14 (not represented in the West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pp. 3, 17.—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 9, 64; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 19, 30, 31, 35, 42, 77, 84, 89, 99, 230, 231, 235, 240; Vid. Medd. Dansk Nat. Foren., vol. 83, 1927, p. 20.—A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 637; Treubia, vol. 14, livr. 2, 1933, p. 211.—EKMAN, Zoogeographica, vol. 2, Heft 3, 1934, p. 364 (zoogeographic and paleontological relationships).—A. H. CLARK, Temminckia, vol. 1, 1936, p. 300.—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 8.—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 103.—H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 29.

Diagnosis.—A family of the superfamily Mariametrida in which the elements of the IBr series are united by syzygy and the arms are 10 or more in number. The perisome of the disk is more or less completely covered by rounded plates, which do not, however, form a solid pavement (see Part 2, p. 226, fourth paragraph); the lateral perisome of the pinnules may contain a few spicules but is usually quite without calcareous deposits (see Part 2, p. 236).

Geographical range.—From southern Japan, the Bonin and Philippine Islands, and Hongkong southward to Sandon Bluffs, New South Wales, and to between Fremantle and Geraldton, Western Australia, and westward to Ceylon.

Bathymetrical range.—From the shore line down to 914 meters; the species are mainly inhabitants of shallow water.

Remarks.—The occurrence of a syzygy between the elements of the IBr series easily distinguishes the species of this family from all other comatulids except only those belonging to the family Eudiocrinidae. The latter, however, possess but five arms, a character that gives them a very distinctive appearance.

In the genus *Catoptometra* the syzygy between the elements of the IBr series is very brittle, and specimens of all the species of this genus when captured in the usual way by the dredge always have at least one of the postradial series, and not infrequently all of them, broken away at this point so that the syzygy is very evident. Furthermore, the species of *Catoptometra* have a very distinctive appearance owing to the stout, smooth, strongly recurved, and usually short cirri, and the unusual development of the spines on the distal borders of the brachials and usually also on the borders of the elements of the division series. In color most of them are unique in being scarlet and bright yellow in usually broad alternating bands; but some of them are, and others may be, olive-green, brown, or dull yellow.

In the genus *Zygometra* the syzygy between the elements of the IBr series is tough and is almost never broken through during capture. Their numerous arms give these species a striking similarity to species of Himerometridae with which they are easily confused.

In identifying any multibrachiate comatulid, therefore, the first step after the determination of the presence or absence of a comb on the oral pinnules (the presence of a comb places the specimen at once in the Comasteridae) should always be the critical examination of the articulation between the elements of the IBr series. If this is a fine straight dotted line, indicating the presence of a syzygy, the specimen belongs to some species of *Zygometra*. It is not long before one becomes very adept at recognizing the species of *Zygometra* at sight, for they have a very characteristic appearance difficult to define. In the smaller species the usually long sharp spines on the outer cirrus segments distinguish them at once from any of the species of Himerometridae with which they might be confused, while the large stout cirri of the large Australian species, coupled with the characteristic oral pinnules, are equally diagnostic. Nevertheless it is always possible to confuse the small species with species of *Heterometra* and the large species with species of *Himerometra*, so that no matter how familiar one may be with these creatures the articulation between the elements of the IBr series should invariably be examined.

History.—In his report upon the comatulids collected by the *Challenger* published in 1888 Dr. P. H. Carpenter placed the three forms of *Antedon*, as understood by him, in which the elements of the IBr series are united by syzygy instead of synarthry (*Antedon fluctuans*, *A. multiradiata*, and *A. microdiscus*) under the heading *Antedon*, Series I. Although these three forms were the only ones formally included by him under this heading, he said that it is probable Müller's *Comatula tessellata* (=*Amphimetra tessellata*) belongs also to Series I, though he had never been able to get a sight of the type specimen, it being the only one of all the described species of *Antedon*—if, indeed, it be an *Antedon*—that he had not personally examined. As contemplated by Carpenter, Series I of *Antedon*, including species in which the elements of the IBr series are united by syzygy, was the equivalent of Series II, including 10-armed species, Series III, including species with IIBr 2 series, and Series IV, including species in which the IIBr series are 4(3+4). In a note written after his account of the forms included under Series I had been printed, Carpenter said that these forms may be considered conveniently as belonging to the *Elegans* group, named for *Antedon elegans*, which had been described by Prof. F. Jeffrey Bell in 1884, but in which the occurrence of a syzygy between the elements of the IBr series had escaped notice until after his discussion of Series I.

In his account of the comatulids collected by Dr. John Anderson in the Mergui Archipelago published in 1889 Carpenter further discussed the *Elegans* group in connection with *Antedon elegans* (*Antedon elegans* is *Zygometra elegans*, but the specimens from the Mergui Archipelago represent *Z. comata*) and described a new species, *Antedon* (*Pontiometra*) *andersoni*, which he said may be for the present referred to the *Elegans* group.

Dr. Clemens Hartlaub in 1895 divided the comatulids into two series, Series I, with plated ambulacra, divided into two sections, *a*, with the elements of the IBr series united by synarthry, including the *Basicurva*, *Acoela*, *Spinifera*, and *Granulifera* groups, and *b*, with the elements of the IBr series united by syzygy, including the *Elegans* group only; and Series II, with unplated ambulacra, including the *Eschrichti*, *Milberti*, *Tenella*, *Palmata*, and *Savignyi* groups.

In my paper on new genera of recent crinoids published on April 11, 1908, the new family Zygometridae was proposed, though not formally defined, and in it were included the genera *Eudiocrinus* and *Zygometra*.

In a paper published on May 14, 1908, though written before the one just noticed, the family Zygometridae is given as including the genus *Zygometra* only, and the range of this genus (which at that time included *Catoptometra*) is added. The characters of the family are made evident in a key to the families of the Comatulida having recent representatives. The genus *Eudiocrinus*, together with *Decametrocrinus*, is included in the family Eudiocrinidae. At the time this paper was written my idea of *Eudiocrinus* was based upon the species assigned to that genus and described in detail and figured in the *Challenger* report, of some of which I had abundant material collected by me in southern Japan. After the paper had been submitted for publication, I received from Japan a specimen of a new species of *Eudiocrinus* (*variegatus*) allied to the type species, *E. indivisus*, which showed that these forms are allied to the species of *Zygometra*, whereas those described in the *Challenger* report are of a wholly different nature. For the latter in the preceding paper the genus *Pentametrocrinus* had been proposed and the new family Pentametrocrinidae had been suggested to include this and the genus *Decametrocrinus*.

This was explained in detail, the families Zygometridae and Pentametrocrinidae were diagnosed, and the genus *Eudiocrinus* was redefined and the included species listed, in a paper published on June 20, 1908.

In 1909 the family Zygometridae was assigned by the author to the Comatulida Oligophreata, together with the families Comasteridae, Himerometridae, Colobometridae, Thalassometridae, and Tropiometridae. The status of the family Zygometridae has since remained unchanged; but in the present work the genus *Eudiocrinus* has been removed from it, the special family Eudiocrinidae (redefined) being created for its reception.

KEY TO THE GENERA OF THE FAMILY ZYGOMETRIDAE

a^1. Segments in outer portion of cirri with prominent sharp dorsal spines (Philippine Islands and Hongkong south to Sandon Bluffs, New South Wales, and to between Fremantle and Geraldton, Western Australia, and westward to Ceylon; 0–128 [?135] meters)--------**Zygometra**, p. 79.

a^2. No dorsal spines on distal cirrus segments (southern Japan, Bonin and Philippine Islands, Hongkong, and southward to Lesser Sunda Islands; 25–914 meters)--**Catoptometra**, p. 125.

Genus ZYGOMETRA A. H. Clark

Hyponome Lovén, Forh. Skand. Naturf. Møde Christiania, vol. 10, 1868 (1869), p. liv (description; genotype, *H. sarsii* [= detached visceral mass of *Antedon microdiscus* Bell, 1882]); Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 159 (same); Can. Nat., new ser., vol. 4, 1869, p. 265 (same).—Lütken, Vid. Medd. naturh. Foren. Kjøbenhavn, 1869 (1870), pp. 185, 186, footnote, 187, 188, footnote.—P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 388 (identity with *Antedon*); Nature, vol. 19, 1879, p. 450.—Perrier, Compt. Rend. Acad. Sci., vol. 96, 1883, p. 450.—P. H. Carpenter, Ann. Mag. Nat. Hist., ser. 5, vol. 11, 1883, p. 336 (identity); *Challenger*

Reports, Zoology, vol. 26, pt. 60, 1888, pp. 87, 89, 97.—Bather, *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, p. 195.—A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 348 (not available as a substitute for *Zygometra*); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 524 (type unidentifiable; not available as a substitute for *Zygometra*).

Comatula (part) P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 23, footnote.

Hypomene Wachsmuth and Springer, Proc. Acad. Nat. Sci. Philadelphia, 1881, p. 202 (p. 28 of separate).

Antedon (part) Bell, Proc. Zool. Soc. London, 1882, p. 534, and following authors.

Hyponeme Rolleston and Jackson, Forms of animal life, 1888, p. 573.

Zygometra A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 339 (new species described as *Zygometra koehleri* [=*Catoptometra hartlaubi*]), pp. 345, 347 (diagnosis; genotype, *Antedon microdiscus* Bell, 1884), Bull. Mus. Comp. Zool., vol. 51, 1908, p. 246 (characters; genotype); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (closely related to *Eudiocrinus*, restricted; arm structure), p. 135 (assigned to the family Zygometridae); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Zygometridae), p. 212 (occurs in Japan [refers to *Catoptometra*]), p. 271 (relation to *Eudiocrinus*), p. 276 (referred to the Zygometridae), p. 542 (listed); vol. 35, 1908, p. 118, fig. 15 (arm structure); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 2 (cirri and lower pinnules comparable to those of Thalassometridae), p. 174; Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 439 (3 peculiar Australian species); Mem. Australian Mus., vol. 4, 1911, p. 715 (recent species first described in 1882; fossil representatives), p. 724 (Australian species), p. 732 (in key), p. 734 (key to Australian species), p. 760 (reference; characters; range); Rec. Indian Mus., vol. 7, pt. 3, 1912, p. 267 (new species discovered related to *Z. comata* but occurring farther west); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 1 (*Hyponome sarsi* the detached visceral mass of some species of this genus); Crinoids of the Indian Ocean, 1912, p. 9 (occurs in shallow water in a very limited area; also in the European Jura; possesses additional species in Australia), p. 10 (does not extend north of Hongkong; absent from Japan; reason), p. 11 (occurs in Mergui Archipelago), p. 21 (range; this closely parallels that of *Comatula solaris* and *C. pectinata*), p. 56 (in key), p. 103 (synonymy; type); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 311 (discussion of the small species and comparison with those of *Heterometra*, and of the large species and comparison with those of *Himerometra*); Journ. Washington Acad. Sci., vol. 5, 1915, p. 8 (very highly developed in the Australian fauna).—F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Pap. 90–L, 1915, p. 195 (inorganic constituents of the skeleton); Prof. Pap. 102, 1917, pp. 23 ff. (same).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 59 (key to the included species).— F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Pap. 124, 1922, p. 20 (analysis of skeleton).— Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 35 (brachial homologies), p. 84 (distal intersyzygial interval); Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.

Diagnosis.—A genus of Zygometridae in which the outer cirrus segments are much shorter than the earlier and bear prominent dorsal spines.

Geographical range.—From Hongkong and the Philippine Islands southward to Sandon Bluffs, New South Wales, and to between Fremantle and Geraldton, Western Australia, and westward to Ceylon.

Bathymetrical range.—From the shore line down to 128 (?135) meters. The species are especially inhabitants of the sublittoral zone.

Remarks.—of the six species included in this genus four are closely allied, while the other two are rather widely different from these and from each other. When typically developed, *Zygometra elegans* is easily distinguished from *Z. microdiscus*, but some specimens seem to be more or less intermediate, so that the former has been considered as simply a form of the latter. The relation between *Zygometra elegans* and *Z. comata* is essentially the same as that between *Z. microdiscus* and *Z. elegans*. In most cases *Z. comata* is readily distinguishable from *Z. elegans*, but specimens may be found that are intermediate in practically all their characters. *Zygometra andromeda* is simply a highly ornate from of *Z. comata.*

The range of the small and generalized *Z. comata* includes the whole Indo-Malayan region, and it also reaches northwestern Australia. *Zygometra microdiscus* and *Z. elegans* are confined to the Australian region; *Z. microdiscus* occurs in the Aru Islands from which *Z. elegans* is not known, but *Z. elegans* extends much farther south on both the east and the west coasts than *Z. microdiscus.* So far as we know at present *Z. punctata* is confined to northeastern and northern Australia and the Aru Islands, while *Z. pristina* has been reported only from the Philippines.

History.—Prof. Sven Lovén's so-called recent cystidean *Hyponome sarsi,* described in 1869, was based upon a detached visceral mass of some species of this genus. There can be little doubt that this species was the one later (1884) described by Bell as *Antedon microdiscus.* Though in all probability *Antedon microdiscus,* the type of the genus *Zygometra,* is identical with *Hyponome sarsi,* the type of the much earlier genus *Hyponome* (see page 95), no useful purpose would be served by substituting *Hyponome* for *Zygometra.* Technically the slight doubt that may be considered to exist in regard to the identity of *Hyponome sarsi* and *Antedon microdiscus* may be regarded as sufficient to justify the continued use of Bell's name *microdiscus* in place of *sarsi,* and of the generic name *Zygometra* instead of *Hyponome.*

In his report upon the *Challenger* comatulids published in 1888 Dr. P. H. Carpenter set apart as *Antedon,* Series I, those species in which the elements of the IBr series are united by syzygy. In this group he included *fluctuans, multiradiata,* and *microdiscus.* Later in the same volume he added Bell's *elegans,* under which he placed *fluctuans* as a synonym, and also an unnamed species [=*Pontiometra andersoni*] from the Mergui Archipelago. Except for the inclusion of the last named, Carpenter's Series I of *Antedon* coincides exactly with *Zygometra* as now understood.

The genus *Zygometra* was diagnosed and the type species designated as *Antedon microdiscus* Bell, 1884, in a paper published on October 29, 1907. But in the article just preceding this in the same volume, which was published on the same day, a new species was described under the heading "*Zygometra koehleri,* sp. nov." In this volume the description of *Zygometra koehleri* is found on page 339, while the genus *Zygometra* is diagnosed on page 347.

Zygometra koehleri is merely the young of the species now known as *Catoptometra hartlaubi,* and it might be argued that since the generic name *Zygometra* was first mentioned in the combination *Zygometra koehleri,* this form is really the type of *Zygometra* and consequently *Zygometra* should replace the later *Catoptometra* as used herein. As nothing would be gained by such substitution, which would certainly result in endless confusion, the generic names *Zygometra* and *Catoptometra* are in the following pages used in the sense in which they have been uniformly employed during the past 30 years.

As first proposed, the genus *Zygometra* included all the species of comatulids with the elements of the IBr series united by syzygy, but in 1908 those species in which the outer cirrus segments are smooth dorsally were removed from *Zygometra* and placed in the new genus *Catoptometra,* leaving *Zygometra* as understood herein.

KEY TO THE SPECIES IN THE GENUS ZYGOMETRA

a^1. More than 40 cirrus segments; more than 35 (usually 40 or more) arms.
  - b^1. More than 40 (65–100) arms; all, or most, of the IIIBr and following division series 4(3+4); usually 45–55 cirrus segments; proximal pinnules very stout and very long (20–32 mm.), tapering to a slender and flagellate tip; cirri very long and stout (Aru Islands and northern Australia south to Shark Bay, Western Australia, and Port Curtis, Queensland; 0–128 [?135] meters) ---------- **microdiscus** (p. 82)
  - b^2. About 40 (usually 35–45) arms; most of the IIIBr and following division series 2; usually 35–45 cirrus segments; proximal pinnules of moderate length (14–18 mm.) and not especially stout; cirri not especially long or stout (northern Australia south to between Fremantle and Geraldton, Western Australia, and Sandon Bluffs, New South Wales; Amboina; 0–89 meters) ---------- **elegans** (p. 98)

a^2. Less than 40 cirrus segments; less than 40 arms.
  - b^1. More than 10 arms; syzygy between the elements of the IBr series perfect.
    - c^1. Cirri moderately long, with usually 25–30 segments; usually 25–35 arms.
      - d^1. Distal edges of radials and proximal and distal borders of the elements of the division series and first 2 brachials plain and unmodified (Mergui Archipelago to Lesser Sunda Islands, Holothuria Bank, the Moluccas, Salawatti, Philippines, and Hongkong; 0–73 meters) ---------- **comata** (p. 110)
      - d^2. Distal edges of radials, proximal and distal borders of the elements of the division series, and to a lesser extent the proximal and distal ends of the first 2 brachials thickened and everted, this eversion being finely scalloped or tuberculated (?Ceylon) - **andromeda** (p. 110)
    - c^2. Cirri short and rather stout, strongly recurved in distal half, with not more than 21 segments; not more than 21 arms (Aru Islands and northern Australia, south to Port Curtis, Queensland; 0–50 meters) ---------- **punctata** (p. 120)
  - b^2. Only 10 arms; syzygy between the elements of the IBr series imperfect, the radiating ridges being developed only on peripheral half of joint faces; arms 50 mm. long; cirri XII, 20–21, 12 mm. long (Philippines; 33 meters) ---------- **pristina** (p. 123)

ZYGOMETRA MICRODISCUS (Bell)

Plate 1, Figures 1, 2; Plate 2, Figures 3, 4, 6

[See also vol. 1, pt. 1, fig. 332 (cirrus), p. 283; pt. 2, fig. 136 (arm base), p. 79; pl. 13, figs. 1045, 1052 (pinnules); pl. 14, fig. 1060 (pinnule); pl. 25, figs. 1155–1157 (disk).]

Hyponome sarsi Lovén, Forh. Skand. Naturf. Møde Christiania, July 1868 (1869), p. liv (description and affinities; Cape York, Torres Strait); Öfv. Vet.-Akad. Förh., 1869, pp. 729–731; Compt. Rend. Acad. Sci. vol. 69, Sept. 1869, pp. 711, 712.—Billings, Can. Nat., new ser., vol. 4, 1869, p. 270.—Lovén, Can. Nat., new ser., vol. 4, 1869, p. 265 (detailed description; Cape York); Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 159.—Lütken, Vid. Medd. Naturh. Foren. København, 1869, pp. 184, 185, 186, footnote (discussion); Can. Nat., new ser., vol. 4, 1869, p. 267.—Wyville Thomson, Proc. Roy. Soc. Edinburgh, vol. 7, 1872, p. 417.—P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 388.—de Loriol, Paléontologie française, Terraine jurassiques, vol. 11, pt. 2, 1889, p. 436.—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 271 (food).

Hyponome sarsii Lovén, Amer. Journ. Sci., ser. 2, vol. 48, 1869, p. 429.—Wyville Thomson, Proc. Roy. Soc. Edinburgh, vol. 7, 1871, p. 417.— Schlüter, Zeitschr. deutschen geol. Ges., vol. 30, Heft 1, 1878, p. 29.—Perrier, Compt. Rend. Acad., Sci., vol. 96, 1883, p. 450; Ann. Mag. Nat. Hist., ser. 5, vol. 11, 1883, p. 223.—P. H. Carpenter, Ann. Mag. Nat. Hist., ser. 5, vol. 11, 1883, p. 336; Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 369.—Lockington, Standard Nat. Hist., vol. 1, 1884, p. 140.—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, pp. 67, 85, 166; vol. 26, pt. 60, 1888, p. 97 (identity); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 45 (identity).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 25.—Neviani, Riv. Ital. Sci. Nat., ann. 11, 1891, fasc. 2, p. 6.—A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 348 (identity); Mem. Australian Mus., vol. 4, 1911, p. 761 (same); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 1 (history; identity), p. 11 (specific identity);

Crinoids of the Indian Ocean, 1912, p. 3 (identity); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 22 (food).

Comatula sp. P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 23, footnote (species with first and second distichals and first and second brachials united by syzygies, like second and third radials).

Hypomene sarsi Wachsmuth and Springer, Proc. Acad. Nat. Sci. Philadelphia, 1881, p. 202 (p. 28 of separate), footnote.

Antedon microdiscus Bell, Proc. Zool. Soc. London, 1882, p. 534 (specific formula only).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 747 (specific formula).—Bell, Report Zool. Coll. H. M. S. *Alert*, 1884, p. 155 (specific formula), p. 163 (description; Port Molle, 12 fathoms; Nicol Bay), pl. 15.—P. H. Carpenter, Quart. Journ. Micr. Sci., vol. 27, 1887, pp. 384, 386 (distribution of the sacculi).—von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, p. 6 (*Challenger* station 186; myzostomes).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 97 (description; *Challenger* station 186; Port Molle; Nicol Bay), pl. 37, figs. 4–6; Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 307 (disk compared with that of [*Pontiometra*] *andersoni*).—Walther, Einleitung in die Geologie als historische Wiss., 1894, p. 298 (from Carpenter).—Döderlein, Denkschr. med.-nat. Ges. Jena, vol. 8, pt. 5, 1898, p. 476 (Thursday Island); pl. 36, figs. 2, 2*a*.—Minckert, Archiv für Naturg., Jahrg. 71, vol. 1, 1905, Heft 1, pp. 219 ff. (regeneration).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1577 (listed).—A. H. Clark, Mem. Australian Mus., vol. 4, 1911, pp. 714, 716, 720 (identity; discussion); Smithsonian Misc. Coll., vol. 60, No. 10, 1912 (includes *Antedon multiradiata* P. H. Carpenter); Crinoids of the Indian Ocean, 1912, pp. 31, 33, 39 (identity).

Antedon sp. P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 743 (with 2 distichals the axillary not a syzygy but the first 2 brachials united by syzygy); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 45 (*Hyponome sarsii* a detached disk).

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Zygometra miciodiscus A. H. Clark, Amer. Journ. Sci., ser. 4, vol. 32, p. 130 (significance of distinctive characters).

Zygometra mertoni Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 82 (Aru Islands), p. 90 (description and comparisons; localities), fig. 6, p. 91 (proximal pinnules).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 59, footnote 1 (synonym of *microdiscus*).

Zygometra microdisca H. L. Clark, Echinoderm fauna of Torres Strait, 1921, pp. 5, 7 (history), p. 20 (range).

Zygometra cf. *microdiscus* Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 271 (*Hyponome sarsi;* food).

Diagnostic features.—A large species with usually 65–100 arms from 85 to 145 mm. long, and the longest cirri with usually 45–70 segments; all, or nearly all, the division series beyond the IBr series are 4(3+4); and the proximal pinnules are stout at the base and very long, 20–32 mm. in length, with 25–60 segments.

Description.—The centrodorsal is large and prominent, varying from thick discoidal with a slightly convex dorsal pole about 3 mm. in diameter to more or less hemispherical. The cirrus sockets are arranged in two to four (usually two or three) irregular marginal rows.

The cirri are XVII-L (usually XXXV-XLII), 30–70 (usually 45–55), 25–55 (usually 35–45) mm. long, long and stout. The longest segments, in the proximal half of the cirri, vary from slightly broader than long to slightly longer than broad, being usually about as long as broad, and those beyond the twelfth-twentieth, which is usually a more or less marked transition segment, are much broader than long. The segments beyond the transition segment bear dorsal spines with glassy tips, which are commonly blunt, though well marked, but may be either small or prominent and conspicuous. The opposing spine is strong and sharp, directed obliquely distally, usually, but not always, more conspicuous than the dorsal spines preceding; its height is equal to about half the width of the penultimate segment. The terminal claw is usually half again as long as the penultimate segment and is moderately curved.

The distal edge of the radials may be just visible beyond the rim of the centrodorsal, or the radials may be almost completely concealed, only their anterolateral angles being visible in the interradial angles. The IBr_1 are very short, six to eight times as broad as long, and are either entirely free laterally or just in contact basally. The IIBr series, IIIBr series, and IVBr series are 4(3+4), rarely or exceptionally 2, most frequently the IIIBr series. The IVBr series are usually developed internally in reference to the IIIBr series. The postradial series are strongly convex dorsally and are more or less compressed laterally, often having a fairly distinct ventrolateral rim.

The arms are 40–100 (usually 50–90) in number and are 60–150 (averaging about 110) mm. long. They are smooth, strongly convex dorsally, and laterally compressed. The brachials are at first short and oblong, then short and almost or quite triangular, and later short wedge-shaped, becoming squarish toward the arm tips.

Syzygies occur between brachials 3+4, again from between brachials 23+24 to between brachials 39+40 and from between brachials 42+43 to between brachials 56+57, and distally at intervals of 8–20 (usually 11–15) muscular articulations. Sometimes there is an additional syzygy from between brachials 8+9 to between brachials 13+14.

The proximal pinnules are usually exceedingly long with broad and slightly keeled basal segments, more rarely of moderate length.

P_D and P_P are long and stout, P_P being often rather longer than P_D. P_D may reach 32 mm. in length. P_D and P_P are composed of 40–60 (rarely as few as 25) segments of which the basal are broad, but not especially distinguished, and those following diminish in size and gradually develop a projection of the dorsal edge at the distal end that disappears in the smaller terminal segments. P_1 is more or less smaller than P_P, 18–25 mm. long with 25–56 (usually 30–50) segments of which the basal are broad, about as long as broad, and the distal are half again as long as broad. The proximal portion of the pinnule up to the fifth segment tapers slightly, the pinnule from this point onward becoming more rapidly flagellate. P_2 is usually more or less considerably smaller than P_1, but it may be of the same size or even slightly larger. It is 20–25 mm. long, with 37–56 segments of which the basal are a little flattened. P_3 resembles P_1 and P_2 but is shorter and smaller, up to 20 mm. long with 25–38 segments. P_4 resembles P_3 but is smaller and shorter, up to 13 mm. long with 26 segments. P_5 is 10 mm. long with 24 segments, and P_{10} is 8 mm. long with 15 segments. The distal pinnules are 8 mm. long with about 20 segments.

The disk is 12–15 mm. in diameter and is strongly incised. Usually the disk ambulacra are protected by a well-developed calcareous plating that ceases at the arm bases. The anal tube is more or less completely covered with coarse calcareous concretions. The other interambulacral areas may contain more or less numerous plates, or they may be naked.

Color in life.—Dr. H. L. Clark says that the color is primarily a reddish purple or even deep claret with the dorsal surface of the arms more or less yellow, but the amount of yellow varies enormously; at one extreme are individuals that are practically all purple, really unicolor, and they are not rare, while at the other are those in which the yellow predominates to such an extent that only the tips of the cirri and more or less of each pinnule distally are purple. The most beautiful specimens are yellow or nearly white, finely speckled more or less profusely with purple. In preserved material, even that which has been very carefully prepared, the yellow shades become buff or light brown, and the purple becomes dingy and often distinctly brown. Naturally such museum material fails to give any adequate idea of the beauty of the living animal.

The largest specimen taken by Dr. Clark, from Roebuck Bay, was deep claret with the dorsal side of the arms yellow; some of the young arms were tipped with white. As preserved it is a deep purple, and only distally do the arms show that they were dorsally yellow in life; they are now a light brown dorsally near the tips. The cirri are dark purple, a few of them cream color near the base.

Notes.—One of the two specimens from northwest of Heirisson Prong, Shark Bay, is the finest example I have ever seen of this species. It has about 100 arms, which are 130 mm. in length. The IIIBr series are mostly 2, but all the other division series are 4 (3+4). The cirri are about XXXV, 47–54, from 50 mm. to 55 mm. long; dorsal spines begin to develop from the seventeenth to the twentieth segment. The color is deep purple.

The other specimen is rather small, with about 65 arms which are about 85 mm. long. The IVBr series are usually developed internally in reference to the IIIBr series. The cirri are composed of 37–45 segments and are from 25 mm. to 30 mm. long.

The specimen from South Passage, Shark Bay, has 50 arms 140 mm. long; the cirri are about XXXV, 30–31, stout, 25 mm. in length. One $IIBr_2$ in a IIBr 4(3+4) series bears instead of a pinnule a slightly undersized arm the first division series of which consists of 5 ossicles all apparently united by synarthry and none bearing pinnules. This division series carries two IVBr series, both of which are 4(3+4). The arms have a knotty and irregular appearance which is probably due to parasitization. P_1 is from 23 mm. to 25 mm. long, very stout basally and tapering gradually to a delicate tip, and is composed of from 25 to 27 segments.

Dr. H. L. Clark collected 20 specimens of this species at Broome and 5 at Lagrange Bay of which, he said, the most interesting are the largest and the smallest. The smallest, from Lagrange Bay, has 19 arms 20–25 mm. long; the 12 division series beyond the IBr series (which would give 22 arms) are all 4(3+4); the cirri are XIII, 25–29, relatively very long, more than half as long as the arms. The color is uniformly deep purple. Dr. Clark says that in spite of its small size it is quite a typical *microdiscus*. The largest specimen, in its present dry condition very nearly 300 mm. across, was taken in Roebuck Bay. Dr. Clark says it has about 110 arms, but it is impossible to count the exact number without serious damage to the specimen. The cirri are XLIII, 52–70, from 50 to 55 mm. long; one of the cirri is forked at the tip.

In the specimen from Mjöberg's station 13, as described by Gislén, the centrodorsal is flattened with the bare dorsal pole 3 mm. in diameter. The cirrus sockets are arranged in three or four irregular rows. There are 42 cirrus sockets of which 17 carry large cirri, 16 carry regenerating young cirri, and the rest are empty. The cirri are XVII, 48–51, 40–50 mm. long. From the sixteenth to the twenty-fourth segment onward there is a small distal dorsal tubercle or blunt spine. The first segment is very short, about half as long as the second, and those following increase in length to about the twelfth, which is somewhat longer than broad, and then decrease in length. The blunt dorsal spines, which are directed obliquely forward, are in height equal to about one-fifth the width of the segments that bear them. The opposing spine is in length equal to about half the width of the penultimate segment, and is directly obliquely distally. The terminal claw is half again as long as the penultimate segment, slightly curved, and white like the dorsal spines.

The radials are almost completely concealed, being visible only in the interradial angles. The IBr_1 are very short, seven times as broad as long, and are in contact basally. The IBr_2 (axillaries) are broadly pentagonal, about three times as broad as long. The IIBr series are 4(3+4), except for a single one which is 2. Of the 18 IIIBr series present 11 are 4(3+4) and 7 are 2. The nine IVBr series are all 4(3+4). The division series and first two brachials are laterally flattened with a fairly distinct ventrolateral edge. The arms are between 49 and 60 in number and are about 130 mm. long. They are a little compressed laterally. On the undivided arms the first syzygy is between brachials 3+4, the second is from brachials 30+31 to brachials 39+40, the third is from brachials 49+50 to brachials 56+57, and the fourth is from brachials 61+62 to brachials 64+65. On one arm the syzygies are between brachials 3+4, 8+9, 26+27 and 39+40, and on another between brachials 3+4, 13+14, 30+31 and 49+50. But in general the animal shows fairly definite zones of syzygies crossing all the arms. The anal tube is encrusted with coarse calcarous concretions.

P_1 is 20 mm. to 22 mm. long and is composed of 39–48 segments. The basal segments are about as long as broad, and the distal are half again as long as broad. P_2 is 20 mm. to 23 mm. long with 36–43 segments; as in P_1 the basal segments are a little flattened. P_3 is 20 mm. long with 38 segments. P_4 is 13 mm. long with 26 segments. P_5 is 10 mm. long with 24 segments. P_{10} is 8 mm. long with 15 segments. The distal pinnules are 8 mm. long with about 20 segments. The color in life, according to a note by Dr. Mjöberg, was yellowish white both dorsally and ventrally, the pinnules dark with small rectangular whitish spots. The proximal segments of P_1 have lateral black spots. In alcohol the specimen is yellow-brown, the arms being chocolate-brown ventrally. The segments of the distal pinnules have dark central bands and white ends so that the pinnules as a whole suggest a string of beads.

From Holothuria Bank I have seen one fine specimen and fragments of others.

Bell mentioned three specimens from Nicol Bay, which he found in the British Museum collection and which he said were smaller than the type specimen from Port Molle. He noted that the smallest of these has not more than XXX cirri, which do not have more than 40 segments. The dorsal spines, especially the opposing spine, are better developed than in the type. There are about 50 arms, and in some cases the IIIBr series are 2. The ground color is purplish, marked with yellow bands. I have examined two of these specimens.

The specimen collected by the *Gazelle* in Mermaid Strait may be described as follows: The centrodorsal is thick discoidal with a rather small flat bare polar area. The cirrus sockets are arranged in three closely crowded alternating marginal rows. The cirri are XXV, 51–60, 40 mm. long. The first segment is very short, four or more times as broad as long, those following increasing very gradually in length to the sixth or seventh, after which they remain uniform, usually slightly broader than long, sometimes about as long as broad, to the seventeenth to twenty-fourth. They then decrease in length, soon becoming about twice as broad as long and so remaining to the end of the cirrus. The penultimate segment is rather longer than those preceding, about as long as broad. Up to a point between the seventeenth and twenty-fourth segments the cirri are without dorsal processes, and the segments have a dull surface; there is an indication of a median constriction on each segment. Beyond this point the segments become laterally compressed and develop subterminal dorsal tubercles or small spines which do not, however, become very prominent. The opposing spine is much larger than the dorsal processes preceding. It arises from the entire dorsal surface of the penultimate segment, is about as long as the distal width of that segment, and is directed slightly forward. The terminal claw is about half again as long as the penultimate segment and is rather slender and rather slightly curved.

The disk and the brachial perisome to the last axillary are completely covered with a pavement of small regular plates. The radials are even with the edge of the centrodorsal. The IBr_1 are exceedingly short, regularly oblong and bandlike, basally united interiorly. The IBr_2 (axillaries) are very short, three to four times as broad as long, almost triangular, with the lateral edges not quite so long as those of the IBr_1, laterally rounded and widely free. The IIBr series are 4(3+4), rounded laterally, without marginal processes, and widely free; the $IIBr_1$ are united interiorly for about the proximal half or rather more, the free distal portion of their interior sides diverging at rather more than a right angle. The IIIBr series are always 4(3+4) exteriorly and usually the same interiorly, though here not infrequently 2, thus suggesting the arrangement characteristic of *Himerometra*. The IVBr and VBr series, when present, are 4(3+4). There are about 85 arms approximately 120 mm. long. The first eight brachials are oblong, slightly over twice as broad as long, those following becoming slightly wedge-shaped, about twice as broad as long, gradually changing to oblong, or very nearly so, about two and one-half times as broad as long.

P_D is 30 mm. long, very stout basally but tapering distally and becoming very slender and flagellate in the distal third. It is composed of about 50 segments, which at first are about as long as broad, then broader than long, distally again about as broad as long, and terminally longer than broad. After the end of the proximal third the distal ends of the segments on the dorsal side become prominent, soon developing into rather long dorsal processes which disappear at the beginning of the distal third. P_P is similar to P_D, but rather larger. P_{PP} and P_1 are progressively smaller and shorter, the latter being only about 9 mm. long and very slender, without dorsal projections on the segments. The pinnules in the proximal portion of the arm distal to the oral pinnules are 4 mm. long, small and weak, with 13 segments of which the first three are about as long as broad and the remainder are somewhat longer than broad, becoming about half again as long as broad distally. The distal pinnules are 7 mm. long, slender, with about 20 segments of which the first is short, not quite twice as broad as long, the second is trapezoidal, about as long as the distal width, and the remainder are about half again as long as broad. The middle and distal pinnules are slightly flattened and subcarinate. The color is dark purple, with the cirri and large lower pinnules lighter.

The details of the 14 specimens collected by the *Siboga* at the Aru Islands are as follows:

(1) 65 arms. Color (in alcohol) yellow, with small circular spots of red-brown on the division series and arm bases; cirri yellow in the proximal half, each segment with a narrow dorsal purple saddle, in the distal half light purple.

(2) 60 arms. Similar to the preceding; all the division series are 4(3+4). Cirri 40 mm. long, with 51–52 segments; the transition segment is about the twentieth. Color purple, darkest on the cirri, with a broad mediodorsal line of yellow on each arm.

(3) About 80 arms; one of the division series is 6(3+4). Color yellow-brown.

(4) About 75 arms, about 110 mm. in length. Cirri 37 mm. long. Color yellow-brown.

(5) 85 arms. Color yellow-brown.

(6) About 100 arms. Color yellow-brown.

(7) About 80 arms. Color yellow-brown.

(8) About 65 arms, about 85 mm. long. Cirri 35 mm. long and composed of 49 segments. Color light yellow, concentrically banded with narrow bands of purple; cirri deep purple with occasional large yellow blotches.

(9) Similar to No. 8.

(10) 85 arms, 145 mm. long. Cirri 40 mm. long and composed of 52-55 segments. Color yellow-brown.

(11) 80 arms, about 100 mm. long. Cirri 35 mm. to 37 mm. long and composed of 48–51 segments. P_D 32 mm. long, with about 60 segments. Color nearly white, with the cirri and the sides of the division series and arms deep purple.

(12) About 85 arms. Color yellow-brown dorsally, purple ventrally.

The preceding *Siboga* specimens are all very uniform. Division series of 2 are very rare. The proximal pinnules are typically very large and stout basally, tapering gradually and becoming flagellate distally. The distal edges of the segments in the outer half are prominent.

(13) A young individual with 17 arms about 40 mm. in length. Two of the postradial series bear 2 arms each; two others bear 4 arms each, there being one IIBr 4(3+4) series bearing internally a IIIBr 2 series; the fifth postradial series bears one IIBr 4(3+4) series carrying 2 IIIBr 2 series.

(14) A young specimen with 14 arms 25 mm. long. One IIBr series is present, which bears 2 IIIBr 4(3+4) series. The synarthry between the elements of the IBr series is just beginning to transform into a syzygy.

In the larger specimen collected by Dr. H. Merton west of Ngaiguli, Aru Islands, there are almost 90 arms with an estimated length of about 100 mm. The centrodorsal is thick and hemispherical in form. The cirrus sockets are arranged in 2 or 3 rows. The cirri are XLII, about 50, and reach 45 mm. in length. The 20 distal cirrus segments bear prominent dorsal spines. All the division series without exception are 4(3+4). P_1 is somewhat longer than P_2, reaching 25 mm. in length; the proximal portion to the fifth segment tapers slightly, but from that point onward the pinnule becomes more rapidly flagellate. P_1 and P_2 are composed of 53–56 segments. P_3 and P_4 resemble the first two pinnules in structure but decrease in length and in the number of their component segments. The color in alcohol is whitish; on the dorsal side of the arms there is a broad deep-violet stripe that runs to the centrodorsal; this is narrowly interrupted on almost every axillary.

The smaller specimen has 54 arms. As in the preceding, the division series are without exception 4(3+4). The centrodorsal is as in the other, and bears 45 cirrus sockets. The cirri are composed of about 50 segments. P_1 and P_2 are up to 18 mm. long. As in the case of the other specimen, the disk is lacking.

Dr. Merton's other specimens from the Aru Islands were considered by Reichensperger to represent a new species that he described under the name of *Zygometra mertoni* in the following terms: The centrodorsal is discoidal with a relatively large, quite flat dorsal pole about 3 mm. in diameter. The dorsal pole sometimes shows small rudiments of cirrus sockets. The cirri are arranged in one closely crowded marginal row, and there is rarely the beginnings of a second row. The normally developed cirri are XVI–XVIII, 21–23, from 10 mm. to 12 mm. long. The first and second segments are twice as broad as long, the third is slightly longer than the second, and the fourth is about as long as broad. The fifth–ninth segments are markedly longer than broad, the seventh being relatively the longest. From the tenth onward the segments slowly become more squarish. The sixteenth–nineteenth segments are somewhat broader than long, but the penultimate is again as long as broad. From the eighth onward the segments bear a prominent dorsal spine. The opposing spine is stout and reaches about two-thirds the width of the penultimate segment in length. The terminal claw is strong and strongly curved. The middle cirrus segments have somewhat flaring distal ends.

The radials are rarely visible in the interradial angles. The IBr_1 are very short, about six times as broad as long, sometimes partially concealed by the centrodorsal. The IBr_2 (axillaries) are very short and almost triangular. The elements of the IBr series are united by pseudosyzygy. The IIBr series, which are present in most of the specimens, are strikingly irregular, being sometimes 2 and sometimes 4 (3+4). In one example two of the IIBr series are 2, and three are 4 (3+4). A specimen with 13 arms has 2 IIBr 4 (3+4) series, and one IIBr series 5 (3+4) in which the syzygial pair is regularly formed and is followed by a fifth ossicle as the true axillary. In a IIBr 4 (3+4) series the third ossicle (hypozygal) is very short, half the length of the second, and the axillary is scarcely longer, almost triangular. The 11–16 arms are 45 mm. long. The first and second brachials are similar, moderately thick, and almost discoidal. The first syzygial pair (composed of brachials 3+4) is somewhat longer than the second brachial. The following five or six brachials are approximately oblong, three times as broad as long. Up to this point the ossicles of the division series and the lower brachials are somewhat compressed laterally. The arm now becomes more rounded, and the brachials become triangular, distally again becoming rectangular. From about the twentieth brachial onward the distal ends are rather strongly produced.

The first three pinnules are similar in structure, stout, almost always more strongly keeled than those succeeding, tapering evenly distally and running to a sharp point. P_1 and P_2 scarcely differ. In the largest specimen P_1 measures 6.5 mm. in length and is composed of 16–21 segments, which to about the seventh are broader than long, the third-sixth being about twice as broad as long; the distal segments are very slender, and are up to 3 times as long as broad. P_2 is 7 mm. long and is composed of 18–20 segments, of which the six lowest are from broader than long to about as long as broad, and those following become longer than broad. P_3 is 5 mm. long, with 15–17 segments, of which the relations are as in P_2. P_4 is shorter, stiff, and straight, with broader proximal segments and rapidly tapering distal segments; it measures 3.3 mm. in length and is composed of 14–16 segments. P_5 is the shortest pinnule on the arm; it measures from 3 mm. to 3.1 mm. in length and is composed of 10–13 segments. P_6 is about 3.5 mm. long, and the pinnules following gradually increase to a length of 5 mm. The disk is thickly studded with calcareous granules, which vary from wart-like to pointed. The high cylindrical anal tube and the ambulacra of the disk are prominently plated. The disk measures 5–7 mm. in diameter.

In Döderlein's specimen from Thursday Island there are 51 arms. The cirri are XLII, about 44; the segments in the distal third of the cirri have dorsal spines. Syzygies occur between brachials 3+4, again from between brachials 27+28 to between brachials 29+30, between brachials 43+44, 55+56, and so on. P_1 and P_2 are about equal in length. P_1 has about 25 and P_2 about 37 segments. P_3 is shorter than the preceding pinnules and is composed of about 25 segments. There is no plating on the disk. The color is whitish, each segment of the division series, arms, cirri, and proximal pinnules bearing a transverse stripe often broken up into spots. Only a few cirri are dark brown to the tip. Döderlein remarked that although the number of arms is less than in the specimens described by Bell and Carpenter, and the fifth forking of the postradial series mentioned by Carpenter as a specific character is not present, he has no doubt that this specimen really belongs to the present species.

The detached disk from Cape York in the Hamburg Museum, which was described by Lovén under the name of *Hyponome sarsi*, presents no characters by which it may be distinguished from a detached disk of this species, in which, as in all the species of the family, the disk is very easily lost. On the other hand, there is no way by which a detached disk could be definitely determined as of this species.

In the *Challenger* specimen from station 186, as described by Dr. P. H. Carpenter, the centrodorsal is relatively large with the dorsal surface slightly convex and free of cirri. The cirrus sockets are arranged in about three rows. The cirri have 40–45 segments, few or none of which are longer than broad and the distal are quite short with tolerably well-marked dorsal spines, the opposing spine being sharp and distinct. The radials are barely visible. The elements of the IBr series are united by syzygy. The postradial series divide 4 and sometimes 5 times. Except for the IBr series, all the division series are 4 (3+4). The brachials are smooth, the proximal short and nearly triangular, those after about the sixtieth becoming more oblong. Syzygies occur between brachials 3+4, again at about the thirty-first brachial, and distally at intervals of 13–15 muscular articulations. P_D and P_P are large and stout, P_P being rather the longer. They are composed of 40–50 segments of which the lower are large but not specially marked and those following diminish in size but gradually develop a projection of the dorsal edge at their distal end which disappears in the smaller terminal segments. The third and following pinnules decrease rapidly both in length and in stoutness, after which the length slowly increases again. The disk ambulacra are protected by a well-developed calcareous plating, which ceases at the arm bases. The anal tube is also considerably plated, but the other interambulacral areas are unprotected. Sacculi are very abundant on the pinnules. The color in alcohol is brownish white, with the perisome mottled with gray.

The specimens from *Challenger* station 187 were described by Carpenter as a new species under the name *Antedon multiradiata.* According to Carpenter the centrodorsal is a thick and slightly convex disk. The cirri are marginal. The cirri are XX–XXV, 40–50+, rather long. Few or none of the segments are longer than broad, and those in the distal half have a small blunt spine projecting slightly forward. The opposing spine is strong and sharp. The radials are visible. The IBr_1 are short and free laterally, and are united to the IBr_2 by syzygy. The postradial series are quite free and may divide four times, the division series being 4(3+4). There are about 40 arms, composed of short and smooth triangular brachials, which become blunter and squarer toward the arm ends. Syzygies occur between brachials 3+4, the next anywhere from between brachials 17+18 to between brachials 46+47, and those succeeding at intervals of 8–20 muscular articulations. P_D is of moderate length and is composed of about 25 stout segments. The pinnules following gradually decrease in size to P_1, and P_2 and P_b are considerably smaller. The succeeding pinnules increase slowly in size but never become very large. The disk is much incised and is paved with large plates between the ambulacra, which are elevated ridges with plated walls; but the plating scarcely extends beyond the level of the outermost axillary. The disk is about 15 mm. in diameter, and the arms are probably about 60 mm. long. I examined these two specimens in the British Museum and found them to be small examples of the present species.

Bell described *Antedon microdiscus,* which was based upon a single specimen from Port Molle in 22 meters, in the following terms: The centrodorsal is rather large and prominent, bearing marginal cirri in 2 or 3 rows. The cirri are XXX–L, 50–70, nearly 50 mm. long. None of the cirrus segments are markedly longer than broad. As a rule the distal two-thirds bear an inconspicuous dorsal spine, and the opposing spine is hardly more conspicuous. The radials are visible. The radials and the elements of the IBr series are very short and wide, and the IBr_1 are not in lateral contact. The IIBr series are 4(3+4). "Three palmars, the axillary normally a syzygy. The arms may divide again, and of the three joints the axillary may or may not be a syzygy." There are probably as many as 90 arms in an adult. The arms are stiff and straight and about 150 mm. in length. The earlier brachials have fairly even edges and are well rounded dorsally and flattened laterally. Those succeeding are faintly wedge-shaped, the distal edge of each projecting alternately on each side into a slight protuberance. The arms generally, though slender, are very firm and stiff and are set very close to one another. Syzygies occur between brachials

3+4, again from between brachials 23+24 to between brachials 26+27, and from between brachials 42+43 to between brachials 43+44, and distally at intervals of from 11 to 13 muscular articulations. The earlier pinnules are exceedingly long in the adult, with very stout and slightly keeled basal segments. P_2, which is a good deal longer than P_1, has as many as 50 segments and is rather fine at its free end. The more distal segments are provided with a spine or tuft of spines. The disk, which has rounded incisions, is about 12 mm. in diameter. The disk, and the arms as far as their last division, are largely washed with purple. The middle line of the arms is lighter, but patches or spots of purple are to be found at the sides. The ventral surface is a little lighter on the disk than on the arms, where it is almost black.

Bell figured this specimen in dorsal view. There are 89 arms, and all the division series beyond the IBr series appear to be 4(3+4). The division series of three ossicles with "the axillary not a syzygy" mentioned by Professor Bell are undoubtedly 4(3+4) series in which the syzygy between the two outer elements was overlooked. Bell figured a cirrus with 59 segments of which the longest are at least half again as broad as long. His figure of the ventral surface, which is to a certain extent schematic, shows a disk in process of regeneration. Bell did not mention the syzygial union of the elements of the IBr series, which he could scarcely have suspected unless one of them had been broken. But his figure shows the extremely short IBr_1 with a straight distal edge which we have since learned to associate with such a union.

I have examined Bell's type in the British Museum. The disk is in the early stages of regeneration. The enormously long proximal pinnules, which recall those of such species of *Himerometra* as *H. bartschi*, and the very long cirri, which are 40–45 mm. in length, are the characteristic features of the species.

The specimen recorded by Dr. H. L. Clark from off Port Curtis is small, with only 22 arms. Of the eight IIBr series present, seven are 4(3+4) and one is 2. There are four IIIBr series, all 4(3+4). The centrodorsal is low and conical. The cirri are XXV–XXX, 40+. P_2 has 27 segments and is relatively large but less than 20 mm. long. The color, dry, is a uniformly pale brown.

Abnormal specimens.—In the specimen from South Passage, Shark Bay, one $IIBr_2$ in a IIBr 4(3+4) series bears, instead of a pinnule, a slightly undersized arm the first division series of which consists of five ossicles, all apparently united by synarthry, and none bearing pinnules. This division series carries two IVBr series, both of which are 4(3+4). The arms have a knotty and irregular appearance, probably due to parasitization.

In an example with about 80 arms from *Siboga* station 273 one of the division series is 6(3+4).

Remarks.—*Zygometra microdiscus* and *Z. elegans* are very much alike, and whether they should be regarded as two species or as merely two incompletely differentiated forms of the same species is more or less a matter of personal opinion. The relation between them is of much the same order as the relation between *Comatula solaris* and *C. cratera*, between *Comatula pectinata* and *C. purpurea*, or between *Comanthus timorensis* and *C. parvicirra*. While most specimens may at once be referred either to one or to the other, some are undeniably intermediate and would fit equally well in either.

Excluding obviously young individuals, specimens of *Z. microdiscus* have 65–100 arms, the average number being 71. The arms are 85–145 mm. long, averaging 118 mm. in length. In *Z. elegans* the arms are 26–80, though almost always between 35 and 45; the average number is 41. The length is 70–110 mm., averaging 99 mm. The number of the cirri is about the same in both forms.

In *Z. microdiscus* the number of cirrus segments is 30–70, usually varying between 45 and 55; the average number in fully developed cirri is 47. The length of the cirri is 37–55 mm., averaging 42 mm. In *Z. elegans* the number of cirrus segments is 30–56, usually varying between 35 and 45; the average number in fully developed cirri is 42. The length of the cirri is 25–38 mm., averaging 32 mm.

In *Z. microdiscus* P_1 is 20–32 mm. in length, averaging 24 mm., and is composed of 25–60 segments, the average number being 44. In *Z. elegans* P_D is 14–18 mm. long, averaging 16 mm., and is composed of 27–40 segments, averaging 33.

There can be no reasonable doubt that *Hyponome sarsi* is the detached visceral mass of *Zygometra microdiscus*. It is identical with the visceral mass of this species only, and *Zygometra microdiscus* is common in the type locality of *Hyponome sarsi*. Since *Antedon microdiscus* of Bell, 1882, is the same species as that presented by the fragment described as *Hyponome sarsi* by Lovén in 1869, the proper course would seem to be to recognize the species as *Hyponome sarsi* and to reduce *Antedon microdiscus* to the status of a synonym. But while there can be no reasonable doubt of the identity of *Hyponome sarsi* and *Antedon microdiscus* at the same time no wholly conclusive proof of such identity is possible. So it has seemed best to retain the name *Zygometra microdiscus* for this species, admitting that so far as can be determined it is quite the same as the species represented by the fragment described as *Hyponome sarsi*, and admitting also that complete and definite proof of such identity is lacking.

Localities.—Hamburg Southwest Australian Expedition station 16; Shark Bay, Western Australia, northwest of Heirisson Prong; 11–12.5 meters; bottom rocky, with coral; September 13, 1905 [A. H. Clark, 1911] (2, Berl. M., 5966, 6136).

South Passage, Shark Bay; 9 meters; Hamburg Southwest Australian Expedition, June 16, 1905 [A. H. Clark, 1912, 1913] (1, H. M.).

Lewis Island, Dampier Archipelago, Western Australia [A. H. Clark, 1913] (2, B. M.).

Lagrange Bay; 9–15 meters; H. L. Clark, September 1929 [H. L. Clark, 1938].

Broome; H. L. Clark, August and September 1929 and June 1932 [H. L. Clark, 1938].

Mjöberg's station 13; Broome, Western Australia; on the beach at low tide; July 27, 1911 [Gislén, 1919, 1924].

Baudin Island, northwestern Australia; 15–27 meters [A. H. Clark, 1929] (2, B. M.).

Holothuria Bank [A. H. Clark, 1913] (1+, B. M.).

Nicol Bay, northwestern Australia; H. M. S. *Alert* [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1913] (2, B. M.).

Mermaid Strait; *Gazelle* [A. H. Clark, 1909, 1911; Hartmeyer, 1916] (1, Berl. M., 5607).

Siboga station 273; anchorage off Pulu Jedan, east coast of the Aru Islands (pearl banks); 13 meters; sand and shells; December 23–26, 1899 [A. H. Clark, 1918] (14, U. S. N. M., E. 448; Amsterdam Mus.).

Aru Islands; west of Ngaiguli; 14 meters; coarse yellow sand; Dr. H. Merton, February 18, 1908 [Reichensperger, 1913].

Aru Islands; between Batu Kapal and Meriri; 10 meters; Dr. H. Merton, March 30, 1908 [Reichensperger, 1913].

Aru Islands, near Udjir; 10–14 meters; coral rock and sand; Dr. H. Merton, April 16, 1908 [Reichensperger, 1913].

Near Lola, northern Penambulai; 5 meters; Dr. H. Merton [Reichensperger, 1913].

Thursday Island; Prof. Richard Semon [Döderlein, 1898].

Albany Island; H. M. S. *Alert* [A. H. Clark, 1913] (1, B. M.).

Cape York, Torres Strait [Lovén, 1869; Lütken, 1869; Billings, 1869; Wyville Thomson, 1871, 1872; P. H. Carpenter, 1879, 1883, 1884, 1888, 1891; Wachsmuth and Springer, 1881; Perrier, 1883; Lockington, 1884; Hartlaub, 1891; Neviani, 1891; A. H. Clark, 1907, 1911, 1912, 1921] (detached disk, H. M.).

Cape York [P. H. Carpenter, 1887; refers to *Challenger* station 187].

Torres Straits; 18 meters; sand [A. H. Clark, 1913] (1, B. M.).

Challenger station 186; Prince of Wales channel (lat. 10°30′ S., long. 142°18′ E.); 15 meters; coral mud; September 8, 1874 [von Graff, 1887; P. H. Carpenter, 1888].

Challenger station 187; off Booby Island (lat. 10°36′ S., long. 141°55′ E.); 11 meters; coral mud; September 9, 1874 [von Graff, 1884; P. H. Carpenter, 1884, 1888] (2, B. M.).

Somerset Passage; 9–16 meters [A. H. Clark, 1913] (1, B. M.).

Port Molle, Queensland; 22 meters; H. M. S. *Alert* [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1913] (1, B. M.).

Thirteen miles northeast of North Reef, Capricorn group, off Port Curtis, Queensland; 128–135 meters; *Endeavour* [H. L. Clark, 1916] (1).

Geographical range.—Northern Australia south to Shark Bay on the west and Port Curtis on the east, and the Aru Islands.

Bathymetrical range.—Littoral and sublittoral, descending to 128 (?135) meters.

Occurrence.—Dr. H. L. Clark says that this truly magnificent comatulid is by no means rare in the Broome region, but it is not so common as either *Z. elegans* or *Z. comata* and prefers deeper water. Most of the specimens were dredged in 9–15 meters, but a very few were found on the hard sandy bottom of Roebuck Bay during the extreme low tides of September 1929.

History.—Few zoological announcements have created more general interest than the description by Prof. Sven Lovén in 1869 of a living cystidean from Cape York, which he called *Hyponome sarsi.* But the interest in the new cystidean was short lived, for in 1872 Prof. Wyville Thomson wrote that "*Hyponome sarsii* appears, from Professor Lovén's description, to be a true crinoid, closely allied to *Antedon,* and does not seem in any way to resemble the Cystideans." In 1879 Dr. P. H. Carpenter wrote that the voyage of the *Challenger* had settled the question of *Hyponome sarsii,* which was nothing more than the detached disk of a species of comatulid in which the disk is plated. In 1884 Carpenter said that *Hyponome sarsii* is "nothing more than the much plated visceral mass of an *Antedon* common at Cape York" and referred to two figures (pl. 55, figs. 3, 4) showing two visceral masses of *Antedon multiradiata* [=*Zygometra microdiscus*]. Some pages further on he said that the original of *Hyponome sarsii* was the disk of a plated *Antedon*, "very probably of this species, *Antedon multiradiata*." In his memoir on the genus *Actinometra* published in 1879 Carpenter remarked that we are as yet unacquainted with any comatulids in which the elements of the IBr series are united by syzygy and there are more than 10 arms. This remark is followed by a reference to a footnote, and in the footnote he said that in the *Challenger* collection there are three comatulids that answer to this description. One of these three is the present species.

In 1882 Prof. F. Jeffrey Bell published a specific formula for a new species he called *Antedon microdiscus*. In 1884 he described and figured this new species, which had been obtained by the *Alert* at Port Molle, and mentioned a specimen in the collection of the British Museum from Nicol Bay. In 1884 Carpenter noted that in some species of *Antedon* with an incised disk the anambulacral plates are somewhat squamous, with a tendency to overlap one another. He figured two disks illustrating this tendency which had been dredged at Cape York as isolated disks. He said that these disks probably belong to *Antedon multiradiata*, entire individuals of which (undescribed) species had been dredged together with them. He went on to say that in these disks—

> The edges of the interpalmar areas rise rather sharply toward the ambulacra, which are marked by strong ridges with indications of a median groove visible upon their upper surface. The food-groove beneath is really comparatively deep, with its edges plated somewhat regularly and turned in towards one another. This is very marked in the immediate neighborhood of the peristome, which is thus completely closed. It is concealed in the smaller specimen by the large and prominent anal tube which projects forwards over it.

In 1884 Prof. Ludwig von Graff described the myzostomes that Carpenter had found upon the specimens from *Challenger* station 187 and had sent to him, giving *Antedon multiradiata* as the name of the host.

In 1887 Carpenter discussed the distribution of the sacculi in *Antedon microdiscus* and in his new species *A. multiradiata* from Cape York, and in the same year von Graff recorded the myzostomes that Carpenter had found upon a specimen of *A. microdiscus* from *Challenger* station 186.

In 1888 Carpenter described *Antedon multiradiata* in detail from two imperfect specimens and several isolated disks, which had been dredged by the *Challenger* at station 187. In the remarks under this species he said that *Hyponome sarsii* is nothing but one of these *Antedon* disks covered with a well-developed calcareous plating, both at the sides of the ambulacra and in the interambulacral regions. He said that it is not unlikely to have been the disk of *Antedon multiradiata* which was dredged in this condition at *Challenger* station 187, as it has a more extensive plating than the disk of *Antedon microdiscus*.

At the same time Carpenter described a specimen of *Antedon microdiscus* that had been dredged by the *Challenger* at station 186. This was the only specimen of this species dredged by the *Challenger*, and it did not come into Carpenter's hands with the rest of the *Challenger* collection, for it had been given by Sir Wyville Thomson to the National Museum at Stockholm where Carpenter found it during his visit to that museum in August 1886. Later Professor Lovén kindly sent it to him in England for further examination. Carpenter pointed out that in Bell's description of *Antedon microdiscus* he overlooked the syzygy between the elements of the IBr series and also made no mention of any axillaries beyond the IVBr series, although such must be present to bring the number of arms up to 90, the number he describes in the adult while several IVBr series are represented in his figure. Carpenter said that it is the presence of the fourth axillary above the IBr axillary that is one of the characters distinguishing *A. microdiscus* from *A. multiradiata* and that he had not seen any specimen without it, though it is much more frequent in the individual from Port Molle than in those from Nicol Bay and Torres Straits. Carpenter said that these last resemble one another in having a smaller number of cirrus segments and a better-developed opposing spine than the type. Carpenter remarked that the segments of the cirrus figured by Bell are much broader than long, whereas in the *Challenger* specimen this is only the case in the outer part of the cirrus, some of the proximal segments being as long as, or longer than, broad, and in premature cirri the length is distinctly greater than the width, while the opposing spine is especially prominent. Carpenter noted that Bell described the second or palmar pinnule of his type specimen as being a good deal longer than the first or distichal one. But he found that this is not the case in the specimen dredged by the *Challenger*. Furthermore, the pinnules show no trace of the slightly keeled basal segments described by Bell. But the distal edges of the basal segments are somewhat sharp, and beyond the sixth segment they project slightly over the bases of those succeeding. This feature gradually develops into a blunt slightly spinous process, which is most marked at about the fifteenth segment and disappears altogether after the twenty-fifth; but in the palmar pinnule figured by Bell it is not visible until the eighteenth segment and continues until near the end of the pinnule. Carpenter said that it is this feature apparently which led Bell to say that "the more distal joints are provided with a spine or tuft of spines."

In 1898 Prof. Ludwig Döderlein recorded and gave notes upon a specimen from Thursday Island.

In 1909 I recorded a specimen that had been dredged by the *Gazelle* in Mermaid Strait, and in 1911 I recorded two specimens from Shark Bay that had been collected by the Hamburg Southwest Australian Expedition in 1905, and also others from Lewis Island in the Dampier Archipelago, from Holothuria bank, and from northwestern Australia, which I had seen in the British Museum.

After an examination of the type specimens of *Antedon microdiscus* and of *Antedon multiradiata* in the British Museum I, in a memoir on the crinoids of the Hamburg Museum published in 1912, announced that they really represent the same species, I had also examined the type of *Hyponome sarsi,* which is in the Hamburg Museum. and this I placed, with a query, in the synonymy of *Zygometra microdiscus*. A specimen from another locality in Shark Bay was recorded and described.

In a paper on the crinoids of the Berlin Museum published in 1912, I listed the specimens of this species in that institution. These are the two from Shark Bay recorded and described in 1911, and the *Gazelle* specimen from Mermaid Strait.

In a memoir on the crinoids of the British Museum published in 1913, I gave notes upon the 10 specimens of this species in its collection and stated that the two specimens that served Carpenter as the types of *Antedon multiradiata* are simply small examples of the species represented by the type of Bell's *Antedon microdiscus*. In a

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supplementary paper on the crinoids of the Hamburg Southwest Australian Expedition published in 1913 I again recorded and described the specimen from Shark Bay in the Hamburg Museum.

Dr. August Reichensperger in 1913 recorded and described two specimens from the Aru Islands that had been collected by Dr. H. Merton, and at the same time published a detailed description of a new species, which he called *Zygometra mertoni*.

In a paper on the crinoids collected by the *Endeavour* off the coast of Western Australia published in 1914, I remarked that from an examination of the types in London I believed *Antedon multiradiata* to be based upon specimens of *Antedon microdiscus* which had not attained full development, and said further that I would now refer to *Zygometra microdiscus* the specimens I had recorded from northwestern Australia and from Lewis Island in the Dampier Archipelago.

In 1915 Prof. Frank W. Clarke and W. C. Wheeler, of the U. S. Geological Survey, published an analysis of the inorganic constituents of the skeleton of this species, their material consisting of fragments of the specimens collected by the *Siboga* at the Aru Islands.

In 1916 Dr. Hubert Lyman Clark recorded and gave notes upon a specimen dredged by the *Endeavour* off Port Curtis, and in the same year Dr. Robert Hartmeyer again listed the specimens in the Berlin Museum and gave their catalogue numbers.

In my report upon the crinoids of the *Siboga* Expedition published in 1918, I recorded and gave notes upon a series of 14 specimens collected in the Aru Islands. From the characters presented by young individuals in this series it seemed clear that Reichensperger's *Zygometra mertoni* is merely the young of *Z. microdiscus*, and the former was therefore placed among the synonyms of the latter. The analysis of the inorganic constituents of the skeleton of this species was republished in an appendix to the *Siboga* report.

Dr. Torsten Gislén in 1919 recorded and described a specimen from Mjöberg's station 13 and at the same time suggested that Bell's *Antedon elegans* should be regarded as merely a variety of *microdiscus*.

Dr. Hubert Lyman Clark in 1921 published a general discussion of this species based on published records, and in 1924 Dr. Gislén described in detail the pinnule articulations.

In 1929 I recorded a specimen from Baudin Island.

In 1938 Dr. H. L. Clark recorded and gave notes on 25 specimens collected by himself at Broome and Lagrange Bay, Western Australia, in 1929 and 1932.

ZYGOMETRA ELEGANS (Bell)

PLATE 2, FIGURE 5; PLATE 3, FIGURES 7, 8; PLATE 4, FIGURES 9–12

[See also vol. 1, pt. 2, fig. 710 (disk), p. 346.]

Antedon elegans BELL, Proc. Zool. Soc. London, 1882, p. 534 (specific formula).—P. H. CARPENTER, Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula).—BELL, Report Zool. Coll. H.M.S. *Alert*, 1884, p. 155 (specific formula), p. 162 (description; Port Molle; Thursday Island), pl. 13, figs. B, B*a*.—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 23, 31, 48, 52, 53, 55, 56, 90, 94, 96, 97, 130 (discussion), 264–266 (identity with *fluctuans*), 276, 362, 366, 367, 375, pl. 8. figs. 1, 2; Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 305 (discussion, but not the specimens from Mergui or the Philippines, which are *Z. comata*).—DÖDERLEIN, Denkschr. med.-nat. Ges. Jena, vol. 8, pt. 5, 1898, p. 475 (Thursday Island; notes), pl. 36, fig. 1.—

Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1577 (listed).—A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 714 (of *Alert* report = *Z. elegans*), p. 716 (known from Australia), p. 720 (of Döderlein = *Z. elegans*); Crinoids of the Indian Ocean, 1912, p. 31 (of Bell, 1884 = *Z. elegans*), p. 33 (of P. H. Carpenter, 1888 = *Z. elegans* + *Z. comata*), p. 36 (of P. H. Carpenter, 1889 = *Z. comata*), p. 39 (of Döderlein, 1898 = *Z. elegans*).

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Zygometra microdiscus var. *elegans* Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 3 (listed), p. 5 (Station 11), p. 19 (detailed discussion and description of specimens), pl. 1, fig. 5.

Zygometra microdiscus elegans Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 77 (syzygies).

Diagnostic features.—A large species with usually 35–45 arms 70 to 110 mm. long, and the longest cirri with usually 35–45 segments; the IIIBr and following division series are mostly 2, the IIIBr series being commonly 2 internally and 4 (3+4) externally, as in the species of *Himerometra;* the proximal pinnules are slender and moderate in length, P_D being 14–18 mm. long with 27–40 segments.

Description.—The centrodorsal varies from large and flattened hemispherical to small and rather thin discoidal, being usually large and thick discoidal with the dorsal pole slightly concave or almost flat, 2.5–5 (usually 3–5) mm. in diameter. The cirrus sockets are arranged in 2 or 3, sometimes more, crowded and irregular marginal rows.

The cirri are XV–XXXV (usually XX–XXX), 30–56 (usually 36–47), from 25 to 40 (usually 30–35) mm. long and are typically rather large and stout. The first four or five segments are broader than long, the fifth–eighth or –tenth are from nearly as long as broad to somewhat longer than broad, being usually about as long as broad, and those following gradually diminish in length, soon becoming markedly broader than long. On the ninth–fourteenth (usually on the tenth or eleventh), which is a more or less evident transition segment, sharp distally directed dorsal spines appear, which reach a length of from one-third to one-half the width of the segments that bear them. The dorsal spines decrease somewhat in size distally. The opposing spine is larger and more prominent than the spines on the segments immediately preceding, and its base occupies the entire dorsal surface of the penultimate segment. The terminal claw is two or three times as long as the penultimate segment and is rather strongly curved. The cirri about the rim of the centrodorsal are about 10 mm. longer than those about the dorsal pole and consist of about 10 more segments, which first bear dorsal spines one or two segments later.

The distal ends of the radials are just visible beyond the rim of the centrodorsal. The IBr_1 are short, four times as broad as long or even broader, and are entirely free, or sometimes just in contact, laterally. The IBr_2 (axillaries) are short, broadly pentagonal, not much longer than the IBr_1 in the median line. The IIBr series are usually all 4 (3+4), though occasionally 2, and in rare cases as many as half of them may be 2. The IIIBr series are commonly all 2, but more or fewer of them, rarely as many as half, may be 4 (3+4). When IIIBr 4 (3+4) series are developed, they are usually external in reference to the IBr series, as in the genus *Himerometra*, and occasionally postradial series are found in which the outer IIIBr series are 4 (3+4) and the inner are 2; rarely most, or even all, of the postradial series are of this character. The IVBr series, when present, are 4 (3+4). They may be developed either on the outermost side of the post-radial series, or on the innermost side of each IIBr series as in *Himerometra*. The single VBr series reported is 2. The division series are strongly rounded dorsally, and are quite free laterally. The first ossicles immediately following each axillary are interiorly united basally. The elements of the division series and the brachials to about the tenth are markedly smooth and short.

The arms are 26–80 (usually 35–40) in number and are 70 to 110 (most commonly about 100) mm. long. They are strongly convex dorsally and laterally compressed and are composed of smooth and short brachials, which sometimes are as short as in the genus *Himerometra*. The distal ends of the brachials usually do not overlap, but often they are slightly produced and very finely spinous.

The first syzygy is between brachials 3+4, the second is anywhere from between brachials 12+13 to between brachials 53+54 (most commonly somewhere near the former position), and the distal intersyzygial interval is 7–21 muscular articulations.

The elongate proximal pinnules are slender and are often considerably longer on the outermost arms of each postradial series than on the inner. P_D is the longest and largest pinnule, varying from rather slender to moderately stout, long and tapering, 15–18 mm. long with 27–40 segments of which the basal are moderately stout and the terminal are small. P_1 is similar to P_D but smaller; in one case it is 14 mm. long with 31–39 segments. P_2 is similar to P_1 but smaller, with 32–36 segments. P_3 is 9–12 mm. long with 19–28 segments. P_4 is about 8 mm. long with 18+ segments. P_6 is 6 mm.

long with 13 segments. The pinnules followed gradually increase in length, the forty-first pinnule being 9 mm. long with 19 segments.

The disk is much incised, and the interradial areas are more or less covered with rather large plates. The ambulacra as far as the last axillary are raised and strongly plated ridges, but the ambulacra of the arms and pinnules are unprotected by plates.

Sacculi are abundant, especially on the pinnules, and sometimes appear on the outer ends of the plated disk ambulacra.

Color in life.—Dr. H. L. Clark says that this species is, on the whole, much more varied than *Z. microdiscus*, combinations of light grays, buffs, fawn-color, and purple of various shades being usual, while unicolor specimens are rare. A specimen from Darwin was distinctly dull purple and white, the disk whitish or pale cream color, the pinnules tipped with white and also white on the dorsal side.

Notes.—The details of the eight specimens dredged by the *Endeavour* between Fremantle and Geraldton are as follows:

(1) 45 arms, 110 mm. in length. Of the 10 IIBr series present 9 are 4 (3+4) and one is 2. Of the 20 IIIBr series present 17 are 2 and 3 are 4 (3+4). The 5 IVBr series are all 4 (3+4); four of them are developed on the outermost side of the postradial series, the fifth being by the side of one of these. The centrodorsal is large, thick discoidal, with the dorsal pole slightly concave and 5 mm. in diameter. The cirri are composed of 44–47 segments and are 30 to 35 mm. in length. P_D is rather slender, about 15 mm. long, and is composed of 27–29 segments.

(2) 40 arms, about 100 mm. long. Of the 10 IIBr series 7 are 4 (3+4) and 3 are 2. There are 16 IIIBr 4 (3+4) and 2 IIIBr 2 series; two of the IIIBr series are missing. The cirri are composed of 37–42 segments and are 30 to 33 mm. long. P_D is 18 mm. long, rather slender, and is composed of 37 segments.

(3) 40 arms, about 100 mm. long. The 10 IIBr series are 4 (3+4). Of the 18 IIIBr series 12 are 2 and 6 are 4 (3+4). The 2 IVBr series are 4 (3+4). The cirri are composed of 38–39 segments and are about 30 mm. long. The elongate proximal pinnules are slender.

(4) Two of the postradial series are missing. The 3 postradial series present each bear 8 arms, 2 IIBr series and 4 IIIBr series being present in every case. All of the IIBr series are 4 (3+4). Nine of the IIIBr series are 2 and 3 are 4 (3+4).

(5) 38 arms. One of the IIBr series is missing. The 9 IIBr series are 4 (3+4). Of the IIIBr series 10 are 2 and 6 are 4 (3+4).

(6) 36 arms, about 100 mm. in length. The 10 IIBr series are 4 (3+4). Of the IIIBr series 9 are 2 and 7 are 4 (3+4). The cirri are composed of 34–42 segments and are 25 to 35 mm. long.

(7) 36 arms, about 100 mm. long. Of the 10 IIBr series 5 are 4 (3+4) and 5 are 2. Of the IIIBr series 8 are 2 and 8 are 4 (3+4). The cirri are composed of 36–40 segments and are 25 to 30 mm. long.

(8) 34 arms, about 100 mm. in length. The 10 IIBr series are 4 (3+4). The 14 IIIBr series are 2. The cirri are composed of 36–43 segments and are 25–30 mm. in length.

The color of these specimens in life was recorded as very variable.

The specimen probably from the vicinity of Perth has 38 arms, which are about 110 mm. long. All the IIBr series are 4 (3+4). Of the IIIBr series 11 are 2 and 7 are 4 (3+4). The cirri are XXX, 42–44, about 30 mm. long, and are typically large and stout; the dorsal spines commence on the thirteenth or fourteenth segment. The proximal pinnules are considerably larger on the outer arms than on the inner. P_D is moderately stout with 28–30 segments and measures 15–17 mm. in length. The color is purplish white, becoming deep purple on the arms. The proximal part of each segment is crossed by a deep purple band. The cirri are purple, becoming darker in the outer half.

In the specimen from Mjöberg's station 11 as described by Gislén the centrodorsal is hemispherical. The dorsal pole, which is 3 mm. in diameter, is colored by shallow black margined pits where cirri have fallen off. The cirri are XXX, 33–45, from 25–35 mm. long. The cirrus count includes 10 sockets, from which cirri recently have become detached, and 5 young cirri. The cirri in the ventral row are 32–35 mm. long with 42–45 segments, the dorsal processes beginning on the thirteenth or fourteenth, and those in the dorsal row are 25–28 mm. long, with 33–35 segments and the dorsal processes beginning on the tenth. Intermediate cirri have 36 and 42 segments with the dorsal processes beginning on the twelfth or thirteenth. The cirrus segments are mostly broader than long; the segment preceding the one bearing the first spine is the longest and is as long as, or longer than, broad. The length of the dorsal spines is from one-third to one-half the width of the segments. The opposing spine is a little longer than the preceding spines, and its length equals about the width of the penultimate segment; its base occupies the entire dorsal surface of that segment. The terminal claw is two or three times as long as the penultimate segment and is rather strongly curved. The dorsal spines and the terminal claw are white. The basal cirrus segments are distally white.

The radials are very short and are in contact laterally. The IBr_1 are four times as broad as long and are laterally separated. The IBr_2 (axillaries) are broadly pentagonal, a little longer than the IBr_1 in the median line. The 9 IIBr series are 4 (3+4). Of the 15 IIIBr series 14 are 2 and one is 4 (3+4). All the 3 IVBr series present are 4 (3+4). The first ossicles following each axillary are interiorly united basally. The arms are 37+ (probably about 40) and are 105 mm. in length. The elements of the division series and the brachials to about the tenth are markedly smooth and discoidal. The brachials then become more or less wedge-shaped with produced distal edges. Syzygies occur between brachials 3+4, again from between brachials 37+38 to between brachials 40+41, from between brachials 58+59 to between brachials 63+64, and from between brachials 73+74 to between brachials 76+77. On one arm the second syzygy is between brachials 53+54, and on another the third is between brachials 87+88. On one arm arising from a IIBr 2 series the syzygies are between brachials 3+4, 13+14, 19+20, 25+26, 33+34 and 42+43.

P_1 is 14 mm. long, with 31–39 segments. P_2 is 16 mm. long, with 32–36 segments. P_3 is 9–12 mm. long, with 19–28 segments. P_4 is about 8 mm. long, with 18+ segments. P_5 has 13 segments. P_6 is 6 mm. long, with 13 segments. The pinnules following increase in length to P_{41}, which is 9 mm. long, with 19 segments. P_a is 13 mm. long, with about 25 segments. P_b is of similar length. P_c and P_d rapidly decrease in length. P_f is the shortest, the succeeding pinnules increasing again. The disk is lacking. As preserved in alcohol the arms are pale chocolate-brown. The pinnules are dark violet, ribboned with white. The soft parts are dark.

Dr. H. L. Clark, after studying 48 specimens of this species, 44 from Broome and 1 from Darwin collected by himself and 3 from the Capricorn Islands collected by Livingstone and Boardman, wrote that this species is larger but more delicate than *Z. comata,* with more arms and many more cirrus segments. He said that it is hard to see why Gislén treated *Z. elegans* as merely a variety of *Z. microdiscus,* but from his description he suspected that the individual he described as *microdiscus* was really a large *elegans* with the maximum number of arms and cirrus segments. He said that the large series of specimens from Broome show well the following differences between the two species. In *elegans* the IIIBr series are 2, with few series beyond, and those often 2; in *microdiscus* the IIIBr series are 4 (3+4), and the many subsequent series are almost always 4 (3+4). The lowest pinnule in *elegans* is not nearly so flagellate as in *microdiscus,* and is smaller in every way. The color in *elegans* is more varied on the whole.

The largest specimen studied by him had 51 arms about 130 mm. long, and the cirri were XX, 45–56. A very fine specimen from Darwin has only 36 arms, but they are nearly 150 mm. long; the cirri have about 40 segments. The smallest specimen has 31 arms about 45 mm. long; all the IIIBr series are 2; the cirri have 36 segments.

The two specimens from Baudin Island are very small.

The specimen from Amboina is a fine example of the species with 28 arms 160 mm. long. There are 8 IIBr 4(3+4) series, and 10 IIIBr 2 series. The cirri are XXI, 35–44, 35–40 mm. long.

The four specimens from Mermaid Strait have 35–80 arms. The IIBr series are 4(3+4). The IIIBr and IVBr series are usually 2, more rarely 4(3+4). In cases where IIIBr 4(3+4) series are developed they are usually external in relation to the IBr series as in *Himerometra,* and there is also usually one more axillary on the inner side of each IIBr series than on the outer, again as in *Himerometra.* Furthermore, the brachials are exceedingly short and discoidal as in *Himerometra,* so that at a casual glance these specimens might very well be mistaken for examples of a species of that genus.

The form from *Challenger* station 190 was thus described by Carpenter: The centrodorsal is a thick disk. The cirri are about XXV, 30–35. The fifth-eighth segments are much longer than broad and those following diminish in length and gradually develop a sharp forward-projecting spine, which decreases slightly in the short terminal segments, but increases again on the penultimate as the opposing spine to a strong recurved terminal claw. The radials are visible beyond the rim of the centrodorsal. The IBr_1 are free laterally. The postradial series are quite free and may divide four times. The IIBr series are 4(3+4). The IIIBr series and IVBr series (when present) are usually 2. The 26 to nearly 40 arms are 40 to 45 mm. long. They are composed of short, smooth, and obliquely quadrate brachials. Syzygies occur between brachials 3+4, the next anywhere between the thirteenth and sixty-first brachials, and thence at intervals of from 7 to 21 muscular articulations. P_D is long and tapering, with about 40 segments, of which the basal are tolerably stout and the terminal are small. The second, and sometimes also the fourth, brachials have similar but smaller pinnules, and those following decrease slowly in size, becoming long and slender again toward the ends of the arms. The disk is 8 mm. in diameter, much incised, with the interradial regions more or less covered with rather large plates. The ambulacra as far as the last axillary are raised and strongly plated ridges, but the ambulacra of the arms and pinnules are unprotected. Sacculi are abundant, especially on the pinnules, and sometimes appear on the outer ends of the plated disk ambulacra.

Carpenter said that three of the *Challenger* specimens agree very closely in their general characters, though the frequency of the arm divisions, and therefore the number of arms, varies considerably. All the IIBr series are 4(3+4), nearly all the IIIBr series are 2, and IVBr series are present in each individual, and are in the majority of cases 2.

There was secured, however, a fourth specimen that differed from these in many points. The color of the calyx and arms is the same brownish white as in the types, but the cirri have a strong reddish-brown tint (which, according to Carpenter, probably was purple during life) with white bands at the articulations, and the proximal ossicles are relatively shorter, though still longer than broad. The difference between this specimen and the other three is most apparent in the arm divisions. Of the 10 IIBr series, four are 2 and six are 4(3+4), and of the 12 IIIBr series, six are 4(3+4) and six are 2. There are no IVBr series. The arms are somewhat more massive than in the other specimens, and the brachials, instead of being smooth and obliquely quadrate, are relatively shorter and more wedge-shaped, with a slight tendency to overlap.

Bell's record from Thursday Island is based upon a detached disk.

Döderlein recorded a specimen without a disk from Thursday Island. The cirri are about XX, arranged in several closely crowded rows, and are composed of about 36 segments of which the first five are broader than long, those following are nearly as broad as long, and the distal are again broader than long. Dorsal spines are developed from the eleventh segment onward. The IIIBr series are all 2. There are no IVBr series. The color is white, the pinnules spotted and banded with purple; the cirri are for the most part purple, with the basal segments white.

Carpenter mentioned the small specimen from Torres Strait collected by Staff-Surgeon R. W. Coppinger of the *Alert*. He said that, as it was in a somewhat mutilated condition, it was not described by Professor Bell in his report upon the *Alert* collections, but was put aside in anticipation of the arrival of better-preserved material. Carpenter said that it resembles the types of *fluctuans* from *Challenger* station 190 in the shape of the brachials, but it has no IVBr series. It resembles the varietal *Challenger* specimen in having purplish cirri with white bands.

The specimen from Prince of Wales Channel is young, with the arms 20 mm. long. On one of the postradial series the original synarthry between the elements of the IBr series has not as yet become transformed into a syzygy.

The specimen from the lagoon on Mast Head Island has 40 arms; the single remaining entire cirrus has 56 segments.

The example from Mast Head Island has about 60 arms, which are about 70 mm. long. Slightly more division series of 4(3+4) are present than usual.

Of the two specimens from Port Denison, one is a fine example with 60 arms about 100 mm. long, and the cirri XIX, 45–48, from 35 to 40 mm. long. The IIBr series are 4(3+4); the remaining division series are 2, or rarely, on the exterior of the postradial series, 4(3+4). This individual agrees with the four from Mermaid Strait, with which it was compared directly.

The other specimen from Port Denison is considerably smaller, with 29 arms 65 mm. long. The IIBr series are 4 (3+4) and the IIIBr series are 2. The cirri are XX, 35–39.

The type specimen from Port Molle was described by Professor Bell as follows: The centrodorsal is small and flattened, and bears two rows of marginal cirri. The cirri are XXV–XXX, 40, 30 mm. long, with the fifth-tenth segments rather longer than broad, and those succeeding with a short conical spine, which diminishes on the more distal ones but enlarges again somewhat as an opposing spine. The radials are just visible. The IBr_1 are wide and are barely in contact laterally. The IBr_2 (axillaries) are comparatively short. The IIBr series are pretty long, 4(3+4). If the arms divide again the division series are generally 2, but they may be 4(3+4). There are 30 delicate arms, which are 95 mm. long. The earlier brachials have parallel proximal and distal edges; the succeeding brachials become wedge-shaped, but the distal edges do not overlap. Still further out the brachials become shorter and project a little at the sides. Toward the free end of the arms the dorsal surface of each brachial is sharply convex. Syzygies occur between brachials 3+4, 12+13, and 24+25 and distally at intervals of 10–14 muscular articulations. The first two pinnules are stiff and long, longer and stouter than the third and fourth. None of the following pinnules are long, but the rather more distal are the longer. The disk is deeply incised, and the margins of the rays are provided with a well-developed and characteristic calcareous plating. Owing to the incisions the disk is only 8 mm. in diameter. The arms are pinkish flesh-color dorsally, much darker ventrally. The cirri are ringed with purplish and white. In a younger specimen there are purplish spots on the arms dorsally.

Bell expressly remarked that none of the endocyclic comatulids he described in his report on the *Alert* collection had the elements of the IBr series united by syzygy, and so when Carpenter first made a cursory examination of most of the comatulids dredged by the *Alert* he failed to detect the similarity between the three specimens upon which Bell based his *Antedon elegans* and the four *Challenger* specimens upon which his own *Antedon fluctuans* was based. He did, however, recognize his *A. fluctuans* in a small mutilated specimen from Torres Strait which had been considered by Bell too imperfect for description with the rest of the *Alert* collection.

In connection with the revision of the endocyclic comatulids with a synarthry between the elements of the IBr series and the IIBr series 4(3+4) Carpenter later reexamined the three specimens of *Antedon elegans* from Port Molle. He found that in all three the elements of the IBr series are united by syzygy.

The original description (1882) of *Antedon elegans* was simply a so-called specific formula in which it was indicated that the IIBr and IIIBr series are of three elements—that is, 4(3+4). This was later revised by Bell as given above.

Carpenter's reexamination of the type specimens of Bell's *Antedon elegans* convinced him that it is in reality the same thing as his own *Antedon fluctuans.*

Carpenter remarked that of the three specimens obtained by the *Alert* at Port Molle one is very considerably different from the other two, both in color and in the amount of serration of the arms. I examined these specimens at the British Museum. They show that this species has shorter cirri than *Z. microdiscus* and small and weak proximal pinnules.

The specimen from Port Molle in the Australian Museum is small with 18 arms, which are about 50 mm. long, and the cirri XVIII, 22–24. Together with it there are some fragments from a larger individual.

Of the three specimens from Port Curtis one has the centrodorsal large, thick discoidal, with the dorsal pole very slightly concave and 5 mm. in diameter. The cirri are XV, 50–53, from 35 to 38 mm. long. There are 35 arms 80 mm. long. The IIIBr series are 4(3+4) exteriorly and 2 interiorly, as in the genus *Himerometra*. Another has the centro-dorsal discoidal with the nearly flat dorsal pole about 4 mm. in diameter. The cirri are XXXV, 46–48, from 35 to 40 mm. long. Series of 4(3+4) are slightly more numerous than usual. The third specimen is small with 20 arms 60 mm. long. All the IIBr series are present. The dorsal pole of the centrodorsal is flat, 2.5 mm. in diameter. The cirri are XXIII, 20–22, 13 mm. long.

The specimen from off Noosa Head has 29 arms, which are about 100 mm. long. The IIBr series are all 4(3+4). All but one of the IIIBr series are 2. The cirri are XXVII, 45–47. The color (dry) is fawn-color with a faint purplish cast, the articulations being distinctly darker than the segments. The cirri are dull purple, the bases of the cirri and the centrodorsal being pale brownish.

One of the specimens from off Sandon Bluffs has 38 arms nearly 100 mm. long. The cirri are XXXV, about 54. The second has 36+ arms (several are missing), which are nearly 100 mm. long. The cirri are XXX+, 47–53. In both the IIBr series and the IVBr series, when present, are 4(3+4). It is common to have the IIIBr series 4(3+4), although 2 seems to be the usual number. The only VBr series noted is 2. In the first specimen the greater part of the arms is light brown, but basally all the arms are heavily shaded with purple, the articulations in particular being very dark. The cirri basally are dorsally pale brown and ventrally deep purple, but distally the purple becomes very gradually dominant until it includes both surfaces. In the second the arms are light brown with more or less of a purplish cast; basally three of the postradial series are very deep purple, the other two being lighter. The cirri are light brown basally, becoming purple distally.

Localities.—Between Fremantle and Geraldton, Western Australia; *Endeavour* [A. H. Clark, 1914] (8, U. S. N. M., 35174; W. A. M.).

?Vicinity of Perth, Western Australia; Hamburg west Australian Expedition, 1905 [A. H. Clark, 1911] (1, H. M.).

Western Australia [= ?Vicinity of Perth] [A. H. Clark, 1912; Hartmeyer, 1916].

Mjöberg's station 11; 45 miles westsouthwest of Cape Jaubert, Western Australia; 22 meters; July 17, 1911 [Gislén, 1919].

Broome, Cable Beach; Frances L. S. Clark, September 2, 1929 [H. L. Clark, 1938].

Broome; hard sandy bottom; H. L. Clark, August and September 1929 [H. L. Clark, 1938].

Broome; dredged at various points in 5–15 meters; H. L. Clark, June 1932 [H. L. Clark, 1938].

Baudin Island, northwestern Australia; 15–27 meters [A. H. Clark, 1911, 1912, 1913] (1, B. M.).

Baudin Island [A. H. Clark, 1911, 1912, 1913] (1, B. M.).

Amboina; pier; 0–2 meters; *Willebrord Snellius*, May 6, 1930 [A. H. Clark, 1936] (1, L. M.).

Darwin, near Shell Islands; 5–11 meters; on sponge and alcyonarian bottom; H. L. Clark, July 2, 1929 [H. L. Clark, 1938].

Mermaid Strait; *Gazelle* [A. H. Clark, 1909, 1911, 1912; Hartmeyer, 1916] (4, U. S. N. M., 35157; Berl. M., 2963).

Challenger station 190; Arafura Sea (lat. 8°56′S., long. 136°05′E.); 89 meters; green mud; September 12, 1874 [von Graff, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1912, 1913] (3, B. M.).

Thursday Island; H. M. S. *Alert* [Bell, 1884; A. H. Clark, 1911].

Thursday Island; Prof. Richard Semon [Döderlein, 1898].

Torres Strait; 18 meters; sand; H. M. S. *Alert*, 1881 [von Graff, 1887; P. H. Carpenter, 1888; A. H. Clark, 1911, 1912, 1913] (1, B. M.).

Prince of Wales Channel; 13 meters; sand [A. H. Clark, 1911, 1913] (1, B. M.).

Mast Head Island; lagoon [A. H. Clark, 1911] (1, Austr. Mus.).

Mast Head Island [A. H. Clark, 1911] (1, U. S. N. M., 35164).

Port Denison, Queensland [A. H. Clark, 1911] (2, Austr. Mus.).

Port Molle, Queensland; 22–36 meters; rock; H. M. S. *Alert* [Bell, 1884; A. H. Clark, 1911, 1913] (3, B. M.).

Port Molle [A. H. Clark, 1911] (1, Austr. Mus.).

Port Curtis, Queensland [A. H. Clark, 1911] (3, U. S. N. M., 35132; 35161; Austr. M.).

Norwest Islet, Capricorn group; 11 meters; Livingstone and Boardman, December 1930 [H. L. Clark, 1938].

Off Noosa Head, southern Queensland; 29 meters; *Endeavour* [H. L. Clark, 1916] (1, M. C. Z., 712).

Eight miles east of Sandon Bluffs, New South Wales; 64–73 meters; *Endeavour* [H. L. Clark, 1916] (2, Austr. Mus.).

Geographical range.—Northern Australia south to between Fremantle and Geraldton on the west and to Sandon Bluffs, New South Wales, on the east; Amboina.

Bathymetrical range.—From the shore line down to 89 meters; chiefly sublittoral.

Occurrence.—Dr. H. L. Clark says that this is a very common comatulid at Broome, occurring under the same conditions as *Z. comata*. But while occurring with *Z. comata* on open sandy bottoms, this species also occurs among rocks and is frequently dredged on bottoms covered with algae, sponges, and other marine growths.

History.—This species was first noticed by Prof. F. Jeffrey Bell who published a specific formula for it in 1882. He described it in detail from a specimen from Port Molle and figured it in his *Alert* report in 1884. A detached disk from Thursday Island, which had been collected by the *Alert*, he said probably belonged to this species.

In the *Challenger* report upon the stalked crinoids published in 1884 Dr. P. H. Carpenter mentioned *Antedon fluctuans* as an example of a comatulid having a syzygy between the elements of the IBr series and in a footnote gave a specific formula for it.

In 1884 Prof. Ludwig von Graff described the myzostomes from *Antedon fluctuans*, giving as the locality *Challenger* station 190, and in 1887 he recorded the myzostomes from a specimen of the same species which had been dredged by the *Alert* in Torres Strait.

In 1888 Carpenter described *Antedon fluctuans* in detail and figured it on the basis of two mutilated individuals and one fragment and one example of a varietal form from *Challenger* station 190, and a specimen from Torres Strait taken by the *Alert* in 1881. After the printing off of that portion of the *Challenger* report that contained the description of *Antedon fluctuans*. Carpenter had occasion to revise the endocyclic comatulids in which the two elements of the IBr series are united by synarthry and the IIBr series are 4(3+4). Among these, judged from the original description, was *Antedon elegans*. Carpenter had made a cursory examination of the greater part of the comatulids dredged by the *Alert* some time previously, but he had not been able to identify among them any representative of the type that appeared in his working list of new *Challenger* species under the name of *Antedon fluctuans*. Later, however, he had recognized this type in an imperfect specimen from Torres Strait, which was in too mutilated condition for description with the rest of the *Alert* collection. On going over the *Alert* collection again in August 1887, he carefully examined the three specimens of Bell's *Antedon elegans* for the purpose of definitely making out the relationship between this species and others in which the IIBr series are 4(3+4), and he found that in all three of the specimens the elements of the IBr series are united by syzygy, although Professor Bell had expressly noted that among the species of *Antedon* described in the *Alert* report "in no case is the radial axillary a syzygy." Carpenter pointed out that Bell's first formula for *Antedon elegans* indicated that the IIBr series are 4(3+4), and sometimes IIIBr 4(3+4) series are present. But in the *Alert* report Bell said that the IIIBr series are usually 2, but may be 4(3+4). Bell's figured specimen has four IIIBr 2 and one IIIBr 4(3+4) series. Carpenter noted that Bell's formula omitted any reference to IVBr series, which occur in one of his specimens. Carpenter found that Bell's *Antedon elegans* is identical with *Antedon fluctuans*, described earlier in the *Challenger* report. In his discussion of the species he mentioned a number of specimens from the Mergui Archipelago and others from the Philippines, which are in reality *Z. comata*, and also another species from Mergui with the same extensive plating of the disk and a syzygy between the elements of the IBr series, which is *Pontiometra andersoni*.

In 1889 in his report upon the crinoids collected by Dr. John Anderson in the Mergui Archipelago Carpenter again affirmed the identity of his *Antedon fluctuans* with the previously described *Antedon elegans* of Professor Bell. He referred to *Antedon elegans* five specimens from Mergui, which, however, really represent *Z. comata*, and mentioned others from Professor Semper's Philippine collection, which are also *Z. comata*.

In 1898 Prof. Ludwig Döderlein published notes upon and figured a specimen of *Antedon elegans* from Thursday Island.

In 1909 I recorded and published notes upon four specimens from Mermaid Strait that had been collected by the *Gazelle*. In the discussions I mentioned a very large series at hand from Singapore and the Philippine Islands, which I identified with Carpenter's *Antedon fluctuans*, and on the strength of this identification I stated that I could not agree with Carpenter in considering *fluctuans* a synonym of *elegans*. These specimens from Singapore and the Philippines, however, represented in reality *Z. comata*.

Later in the same year I recorded a number of specimens from Singapore as *Zygometra fluctuans*. I pointed out that these specimens agreed closely with Carpenter's description of *fluctuans*, except that the brachials are oblong distally, and further that they all agree among themselves and also with Philippine specimens. I said that I had at first followed Carpenter's lead and had considered them as belonging to *elegans*; but when I examined the collections made by the *Gazelle* in northwestern Australia I found that I was wrong, for in that collection there are specimens of what is undoubtedly true *elegans* that agree with Bell's diagnosis and have much longer and more robust cirri with more numerous segments than any of the Singapore or Philippine specimens. I remarked that, judging from the material at hand, *elegans* and *fluctuans* are both perfectly good species, and there is not the slightest difficulty in differentiating them. The form I regarded as *fluctuans*, however, is in reality *Z. comata*.

In 1911 I recorded and gave notes upon a specimen collected by the Hamburg Southwest Australian Expedition presumably in the vicinity of Perth, and in a memoir on the crinoids of Australia published in the same year I recorded specimens in the collection of the Australian Museum from Mast Head Island, Port Denison, Port Molle, and Port Curtis. In a footnote I diagnosed a new species, *Zygometra comata* (P. H. Carpenter, MS.), to which I referred the specimens from Singapore, the Mergui Archipelago, and the Philippines previously identified by Carpenter as *elegans* and by myself as *fluctuans*. Carpenter's *Antedon fluctuans* I included in the synonymy of *Zygometra elegans*.

In a memoir on the crinoids of the Berlin Museum published in 1912 I listed one specimen from Western Australia and four from Mermaid Strait, and in my monograph on the crinoids of the Indian Ocean published in the same year I gave the synonymy of the species and a list of the known localities.

In 1913 I listed and gave notes upon the specimens I had examined in the British Museum in 1910. In the same year, in recording specimens of *Z. comata* from Hongkong, I gave a detailed comparison between this species and *Z. elegans*.

In 1914 I recorded and gave notes upon eight specimens dredged by the Australian Fisheries Investigations steamer *Endeavour* between Fremantle and Geraldton, Western Australia, and discussed the relationships between this and the other species of the genus.

Dr. Hubert Lyman Clark in 1916 recorded and described three specimens dredged by the *Endeavour* off Sandon Bluffs, New South Wales, the southernmost locality on the east coast of Australia. In the same year Dr. Robert Hartmeyer noted that the specimen from Western Australia that in 1912 I had listed as in the Berlin Museum was now in the Hamburg Museum, the only specimens in the Berlin Museum being those from Mermaid Strait of which he gave the catalogue number.

In 1919 Dr. Torsten Gislén described in detail a specimen from Mjöberg's station 11. He regarded this form simply as a variety of *Z. microdiscus*.

In 1921 Dr. Hubert Lyman Clark published an account of the occurrence of this species in northern and eastern Australia.

In 1938 Dr. Clark recorded and gave notes on 45 specimens collected by himself and Mrs. Clark at Darwin and Broome in 1929 and 1932, and on three collected in the Capricorn Islands by Livingstone and Boardman in 1930. He compared this form in detail with *Z. microdiscus*.

ZYGOMETRA ANDROMEDA A. H. Clark

Zygometra andromeda A. H. Clark, Rec. Indian Mus., vol. 7, pt. 3, 1912, p. 269 (description; "India"); Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 123 (comparison with *Z. elegans*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 59 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 27.

Diagnostic features.—The cirri are XXI, 27–30 (usually 30), and there are 25 arms 50–55 mm. long. The distal border of the radials and the proximal and distal borders of the elements of the division series and to a lesser extent of the first two brachials are thickened and everted, this eversion being finely scalloped or tuberculated so that the edges of the ossicles appear beaded.

Description.—The centrodorsal is thin discoidal with the bare dorsal pole large, slightly concave and finely granular, 2.5 mm. in diameter.

The cirri are XXI, 27–30 (usually the latter), 13 to 15 mm. in length. The longest segments are about one-third again as broad as long. Long and sharp dorsal spines are developed from the eighth or ninth segment onward.

The arms are about 25 in number, 50 to 55 mm. in length. The division series and arms resemble those of *Z. comata*, but the distal edges of the radials and the proximal and distal edges of the elements of the division series, and to a lesser extent of the first two brachials, are thickened and everted, this eversion being finely scalloped or tuberculated so that the edges of the ossicles appear beaded. The summit of the eversion may be smooth, but it is usually very finely spinous. The flattened lateral borders of the division series and first two brachials are very finely spinous; the dorsal surface is unmodified. The distal border of the first syzygial pair bears a row of small rounded obscure tubercles, and there is usually a similar, but less evident, row at the syzygial line. Beyond the fourth brachial the arms are smooth, resembling those of *Z. comata*.

P_1 is 9.5 mm. long and is composed of 24 segments.

Locality.—"India" (probably Ceylon) [A. H. Clark, 1912] (1, I.M).

Remarks.—This species is known only from the type specimen in the Indian Museum, which was described in 1912. Except in the modification of the ends of the radials and ossicles of the division series it does not appear to differ in any way from *Z. comata* (the following species), of which it is probably the ornate western representative.

ZYGOMETRA COMATA A. H. Clark

Plate 4, Figures 13, 14; Plate 5, Figures 15–17

[See also vol. 1, pt. 1, fig. 252 (centrodorsal), p. 253; fig. 333 (cirri), p. 283; fig. 468 (centrodorsal), p. 359; pt. 2, figs. 27, 28 (centrodorsal and radial pentagon), p. 20; figs. 143, 144 (arm base), p. 83; fig. 711 (disk), p. 346; fig. 779 (ambulacral deposits), p. 366.]

Antedon eomata VON GRAFF, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, p. 2 (*nomen nudum;* Padau Bay, Mergui Archipelago; myzostomes).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 465 (status of name).

Antedon elegans (part) P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 265 (Philippines; Mergui Archipelago).—BELL, Proc. Zool. Soc. London, 1888, p. 389, footnote 5 (collected by Dr. Anderson at Mergui).—P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 305 (detailed account; King Island, Mergui), p. 306 (Philippine variety; characters), p. 307 (compared with [*Pontiometra*] *andersoni*).

Zygometra elegans A. H. CLARK, Smithsonian Misc. Coll., vol. 52, 1908, p. 212 (*Albatross* stations 5137, 5138).

Antedon fluctuans A. H. CLARK, Zool. Anz., vol. 34, 1909, p. 367 (not as supposed by Carpenter a synonym of *elegans*).

Zygometra fluctuans A. H. CLARK, Vid. Medd. Naturh. Foren. København, 1909, p. 151 (Singapore; description of specimens), p. 153 (not the same as *elegans*), p. 193 (collected at Singapore by Svend Gad).

Zygometra eomata A. H. CLARK, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 537 (*Albatross* station 5358; number and length of arms, but no further description; also recorded from Singapore); Mem. Australian Mus., vol. 4, 1911, p. 734 (in key), p. 762, footnote (description; previous references; localities; differential characters); Rec. Indian Mus., vol. 7, pt. 3, 1912, p. 267 (range; related species farther west), p. 268 (compared with *Z. andromeda*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 12 (Hongkong); Crinoids of the Indian Ocean, 1912, p. 33 (identity), p. 36 (=*Antedon elegans* P. H. Carpenter, 1889), p. 104 (synonymy; localities); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 178 (range in eastern Asia), p. 180 (8 miles outside of Hongkong harbor, 14 fathoms; notes; comparison with *Z. elegans*); Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 123 (comparison with *Z. elegans*); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (Malayan species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 59 (in key; range), p. 61 (synonymy; notes; Stations 162, 179, 322), pp. 273, 274, 276 (listed); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 637, pl. 44, fig. 15 (80 miles northwest of Penang, 40 fathoms; Singapore); Treubia, vol. 14, livr. 2, 1933, p. 211 (Java Sea, notes).—TH. MORTENSEN, Hong Kong Nat., Suppl. 3, 1934, p. 5 (Hongkong).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, pp. 21, 26, 27; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (French Indochina); p. 5 (range), p. 6 (range), p. 8 (Pulo Condor; notes); fig. 1, p. 9.—H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 29 (Broome; notes).

Heterometra bengalensis (part) A. H. CLARK, Mem. Australian Mus., vol. 4, 1911, pp. 722, 723, 734, 768 (specimen from Holothuria Bank, but not specimens from Port Curtis, which are *Z. punctata*); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, pp. 440, 443, 444, 446 (record from Holothuria Bank); Crinoids of the Indian Ocean, 1912, p. 130 (record from Holothuria Bank); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, pp. 310, 313 (Holothuria Bank).

Zygometra punctata (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 61, 1913, No. 15, p. 21 (Holothuria Bank; 15 fathoms; notes); Die Fauna Südwest Australiens, vol. 4, Lief. 6, 1913, p. 310 (Holothuria Bank); Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 114 (Holothuria Bank); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1915, pp. 224 ff. (reference to Holothuria Bank); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 63 (Holothuria Bank).

Diagnostic features.—The arms are typically 30 in number, there being a IIIBr 2 series on the inner derivative from each IIBr series, so that each ray bears six arms arranged in 1, 2, 2, 1 order. The arms are 40–135 mm. (but usually between 60 and 100) mm. in length. The cirri have typically 30 segments of which the outer have unusually long and slender sharp dorsal spines. The species is, however, rather variable. There may be as few as 14 or 16 or as many as 41 arms, while the longest cirri consist of anywhere between 28 and 45 segments.

Zygometra comata is of more delicate build than *Z. elegans*, and the spines on the outer cirrus segments are much more prominent. It is rather easily mistaken for a species of *Heterometra* unless the articulation between the elements of the IBr series is examined, when the perfectly straight and uniform fine dotted line indicating the presence of a syzygy identifies it at once. The long, slender, and sharp dorsal spines on the outer cirrus segments and the dark ventral saddle-shaped patches commonly present on the cirrus segments also serve to distinguish it at a glance from any similar species of *Heterometra.*

Description.—The centrodorsal is discoidal, broad, with a broad, flat, or slightly concave dorsal pole 5–6 mm. in diameter. The cirri are arranged in usually two irregular and closely crowded marginal rows.

The cirri are X–XXXII (usually about XX), 25–45 (usually 29–35), 15–35 (usually between 20 and 30) mm. long. The first segment is about twice as broad as long and those following increase gradually in length to the fourth or fifth, which varies from about as long as broad to one-third or even one-half again as long as broad. The three or four segments following are similar, and those succeeding gradually decrease in length so that the terminal seven or eight are nearly twice as broad as long. From the sixth to the eighth there is a more or less marked transition segment that does not decrease in width distally, and is seldom with any indication of a dark band. From the sixth–thirteenth (usually seventh–ninth) segment onward long sharp dorsal spines are developed. The opposing spine is long and slender, and is about as long as the penultimate segment. The terminal claw is considerably longer than the penultimate segment, and is rather slender and moderately curved. The longer proximal segments have a slight central constriction.

The distal ends of the radials are visible beyond the rim of the centrodorsal. They are usually plain, but in western specimens may be obscurely beaded. The postradial series resemble in general those of *Z. elegans* but are relatively somewhat longer. The sides of the division series, which are usually in close lateral contact, may be sharply flattened with a distinct dorsolateral line, or they may be barely in contact. The sides of the division series are usually smooth, but occasionally they bear a few irregular spinous processes. The IIBr series are usually all 4(3+4), but one or more may be 2, and in rare cases half, or even the majority, may be 2. The IIIBr series are most frequently all 2 and are usually developed only internally so that commonly the arms on each postradial series are six in number and are arranged in 1, 2, 2, 1 order; but IIIBr 4(3+4) series are not infrequent, and in rare cases half, or even the majority, of the IIIBr series may be 4(3+4). IVBr series are rarely developed, but occasionally one is present, and in one case two were present in a single individual. They are 4(3+4); but in the individual with two, one was 4(3+4) and the other was 2.

The arms are 14–41 (averaging about 25) in number and are 40 to 135 (averaging about 85) mm. long. They are usually of moderate length and moderately tapering, but they may be slender and taper very slowly. The brachials are rather short, in the proximal portion of the arm wedge-shaped and distally oblong; they are sometimes very short, as in the genus *Himerometra.* The brachials after the fourth or fifth have strongly produced and very finely spinous distal edges, making the arms very rough to the touch.

The pinnules resemble those of *Z. elegans* but have fewer segments.

The ambulacra of the disk are very strongly plated and the interambulacral areas, especially the anal area, are also more or less strongly plated.

Color in life.—Dr. H. L. Clark says that in life the colors are yellow and purple, but the relative amounts of the two, their distribution, and the shades show infinite variety. For the yellow the shades range from almost white to deep buff, and for the darker color from light grayish purple to a very deep, rich, reddish purple. The color arrangements are too diversified to warrant description, but it is common to have the arms banded either broadly or narrowly; often only the pinnules are banded and the dorsal side of the arms is prettily mottled, or simply unicolor.

Notes.—In Dr. John Anderson's collection from King Island, Mergui Archipelago, there were five specimens of this species. Of these, two were labeled "sublittoral," two were found on corals, and the youngest had the cirri coiled around a gorgonian (*Plexaura*). As described by Carpenter, the arms of the largest reached 100 mm. in length. Compared with the specimens of *Z. elegans* collected by the *Challenger* in the Arafura Sea and Torres Strait the earlier brachials are relatively shorter with a more wedge-shaped outline and a greater tendency to overlap. The number of arms rarely exceeds 30. There are no IVBr series, and the full complement of IIIBr series is rarely found on any ray. Carpenter noted that as a rule only the 2 inner IIIBr series are present, so that there are 6 arms to a ray arranged in 1, 2, 2, 1 order. The IIBr series are sometimes absent. There is little tendency to any variation from the IIIBr 2 type. The rays of the largest specimen from King Island are in contact, and the elements of the IIBr series sometimes exhibit a tendency to the straight edged and wall-sided form. Two of the specimens are almost black, another is a dark reddish brown mottled with lighter patches, and one has a more uniform lighter shade of the same color.

One of the two specimens from 80 miles northwest of Penang has 30 arms 90 mm. long. Of the 10 IIBr series present 9 are 4(3+4) and one is 2. Two of the IIIBr series are 4(3+4); these are situated side by side on the IIBr 4(3+4) series which is paired with the IIBr 2 series. There is a single IVBr 4(3+4) series on the innermost (nearest the midradial line) branch from a IIIBr 2 series. The division series are in close lateral contact. The longest cirri have 29–35 segments. The transition segment, which is not strongly marked, is usually the seventh or eighth. The color is brownish yellow with narrow and widely spaced deep purple cross bands on the arms.

The other specimen has 14 arms 110 mm. long. All 4 of the IIBr series are 4(3+4). The cirri are XXI, 33–40, 35 mm. in length. The color is light grayish, the arms with narrow and widely spaced deep purple cross bands.

Of the specimens collected by Svend Gad at Singapore one dated April 20, 1906, has 19 arms 70 mm. long. There are 8 IIBr series, all 4(3+4), and a single IIIBr 2 series, developed internally. The brachials after the fourth or fifth have strongly produced and very finely spinous distal edges, making the arms very rough to the touch. The brachials are very short, in the proximal fourth of the arm wedge-shaped and in the distal portion oblong as in *Himerometra*. The cirri are XX, 25–28. The first cirrus segment is about twice as broad as long and those following gradually increase in length to the fourth or fifth, which is about as long as broad. The following three or four segments are similar, and those succeeding gradually decrease in length so that the terminal seven or eight are nearly twice as broad as long. The sixth is a transition segment, its proximal half having a dull and its distal half a highly polished surface. The transition segment does not decrease in width distally, nor is it encircled by a dark band. The sixth and following segments bear long sharp dorsal spines. The opposing spine is long and slender, about as long as the width of the penultimate segment. The terminal claw is considerably longer than the penultimate segment, rather slender, and moderately curved. The longer cirrus segments have a slight central constriction.

Another specimen bearing the same date is similar but has 20 arms due to the presence of all the IIBr series, eight of which are 4(3+4) and two 2.

Dated April 16, 1907, are 15 specimens with 17–25 arms 40 to 50 mm. long. The cirri are XIII–XX. All the IIBr series are 4(3+4). IIIBr series are present in all the specimens, in all cases 2, and developed internally.

Of two specimens dated July 23, 1907, one resembles in general the first mentioned from Singapore. The 20 arms are 75 mm. long. Of the 10 IIBr series 7 are 4(3+4), one is 2, and the remaining two consist of a single ossicle each. The cirri are XXIII, 30, 15 mm. long. The other specimen has 12 arms 50 mm. long. There are 2 IIBr 4(3+4) series. The brachials are somewhat wedge-shaped, longer than in the preceding specimen. The cirri are XX, 25–28, 15 mm. long.

An example dated July 27, 1907, has 24 arms 60 mm. long. The 10 IIBr series are 4(3+4). Four IIIBr 2 series are present, 3 developed internally and one externally. The cirri are XX, 25–30, 15 mm. long.

A specimen with 16 arms 70 mm. long is dated November 27, 1907. Six IIBr 4(3+4) series are present, but no IIIBr series. The cirri are XXII, 30, the transition segment being usually the eighth.

The specimen from Singapore in the British Museum is small, with 20 arms.

The specimen from the Danish Expedition to the Kei Islands station 73 is very small, with 12 arms about 30 mm. long.

The example from the Danish Expedition to the Kei Islands station 101 is small with 13 arms 50 mm. long and is in process of adolescent autotomy.

The specimen from north-northeast of Indramayu Point, Java, has 18 arms.

The specimen from *Siboga* station 322 is small, with 16 arms 60 mm. long. Five of the six IIBr series are 2 instead of 4 (3+4). The cirri are XVII, 27, 17 mm. long. The color is deep purple.

One of the specimens from the Danish Expedition to the Kei Islands station 38 has 22 arms 130 mm. long, slender and very slowly tapering. There are seven IIBr 4 (3+4) series and five IIIBr 2 series, of which three are internal and two external. The cirri are XVIII, 26–30, about 25 mm. long. The other is similar with 26 arms 125 mm. long. The 10 IIBr series are 4 (3+4); of the six IIIBr series, five are 4 (3+4) and one is 2. Three of the IIIBr series are developed externally and three internally.

Of the three specimens from Amboina, one has 24 arms 135 mm. long; the longest cirri have 35 segments. Another has 22 arms with ten IIBr 4 (3+4) series and two IIIBr 2 series, the latter both internal. The cirri have 29 segments. The third has 22 arms, with eight IIBr 4 (3+4) series and four IIIBr 2 series, the latter all internal.

The specimens from *Siboga* station 162 are both young. One with 14 arms is deep purple with a broad mediodorsal line of white on the arms. The other, which is much broken, is entirely deep purple.

The specimen from Holothuria Bank has 18 arms, and the cirri are X, 29–31, 20 mm. long. On the cirri long dorsal spines are developed from the eleventh segment onward.

Dr. H. L. Clark says that the number of arms in specimens from Broome ranges from 11 in a specimen 70 mm. across to 25 in a specimen 115 mm. from tip to tip. Of the 39 specimens he collected and examined the largest are 175–200 mm. across and have 16–24 arms. He remarks that it is hard to see where the line is to be drawn between this species and *punctata*. So far as the number of segments in the cirri is concerned, the series of specimens from Broome shows that there is a considerable range of variation, but only a few large specimens show as many as 25–27; most of them have 20–23. None of the specimens from Broome have fewer than 20 cirrus segments.

The example from *Siboga* station 179 has 20 arms 90 mm. long. There are six IIBr 4 (3+4) series and four IIIBr 2 series present, the latter all internal. The distal borders of the radials are obscurely beaded. The sides of the division series and rays bear a few irregular spinous processes. The cirri are XVIII, 28–33 (usually 30), 25 mm. long. Long dorsal spines are developed from the eleventh to the thirteenth segment onward.

The specimen collected by Dr. Th. Mortensen off Jolo has 41 arms about 100 mm. long. Of the 10 IIBr series five are 4 (3+4), three are 2, and two are 3. Of the 16 IIIBr series eight are 2 and eight are 4 (3+4). The centrodorsal is discoidal, broad, with a broad flat circular dorsal pole 6 mm. in diameter. The cirri are XXXII, 36–45, 30 mm. long.

The specimen from *Albatross* station 5358 has 28 arms 110 mm. long. It resembles others from Singapore with which it was compared.

Of the five specimens from Bantayan Reef four have about 40 arms, and the fifth has about 20 arms.

Carpenter noted (1888) that, while in the specimens from the Mergui Archipelago the ambulacra of the disk are very strongly plated, and also the interpalmar areas at their sides, this feature is less marked in Philippine examples. He also remarked (1889) that the straight-edged and "wall-sided" character of the elements of the IIBr series, a tendency to which is shown by the largest specimens from Mergui, is much more distinct in the specimens from the Philippines.

The specimen from Pulo Condor, as described by Gislén, has 20 arms; of the 10 IIBr series six are 2 and four are 4 (3+4). The cirri are XXII, 25–26. The color is mottled violet and white.

In the better of the two specimens from Hongkong there are about 38 arms, which are about 90 mm. long. There are nine IIBr series, five of which are 4 (3+4), the other four being 2. Of the 15 IIIBr series, 11 are 4 (3+4) and four are 2. The single IVBr series is 4 (3+4). The radials, division series, and arms are similar to those of specimens from Singapore. The centrodorsal is discoidal, very slightly concave—almost flat—on the broad dorsal pole, which is 5 mm. in diameter. The cirri are arranged in two irregular closely crowded marginal rows, and are XXIX, 34–36, from 20 to 27 mm. long. The longest proximal cirrus segments are usually from one-third to one-half again as broad as long, and the outer cirrus segments are two and one-half or three times as broad as long. The eighth or ninth and following bear prominent rather slender dorsal spines which in the outer part of the cirri become more or less broadened laterally, forming short high transverse ridges or ending in a more or less completely bifurcated tip. Toward the extremity of the cirri the dorsal spines again resume their normal character.

The other specimen is similar. There are about 40 arms. The 10 IIBr series are 4 (3+4). Three of the IIIBr series are 2, the remainder being 4 (3+4). Two IVBr series are present, one 2 and one 4 (3+4). The cirri are XXVIII, 33–35, about 25 mm. long.

Both of these specimens are dull pinkish with purple cirri, the earlier segments of the latter with white borders and a white dorsal surface. Except for the greater number of arms these specimens agree perfectly with a series at hand from Singapore and the Philippines.

The specimen from Hongkong collected by A. Wieler in 1888 has 20 arms and seems not to differ from others from Singapore.

Abnormal specimens.—In one of the specimens from Singapore two of the IIBr series consist of a single ossicle each, and in one from Jolo two of the IIBr series consist of three ossicles. In a specimen from Hongkong the dorsal spines in the outer, but not terminal, portion of the cirri are more or less broadened, forming a short high transverse ridge or ending in a more or less completely bifurcated tip.

Local variation.—The smallest specimens, with 12–25 arms 40 to 70 mm. long and the cirri with 25–30 segments, are from Singapore. But this does not necessarily mean that this species does not reach a larger size there. It is quite possible that all the specimens were collected in a restricted area where they never grow to full size, or where at the time they happened to be all young. The specimens from the Mergui Archipelago are essentially like those from Singapore. They rarely have more than 30 arms, which are up to 100 mm. in length.

The greatest arm length occurs in specimens from the Kei Islands and the Moluccas, although here the number of arms is small. The arms are 22–26 in number, reaching a length of 125 to 135 mm. The longest cirri, while they usually have 30 segments, may have as many as 35.

As is commonly the case among the multibrachiate comatulids, the largest number of arms is found in specimens from the Philippine Islands. Here the arms vary from 20 to 41 in number, with a maximum length of 110 mm. The cirri may have as many as 45 segments. In Philippine specimens the disk is less heavily plated than in specimens from the Mergui Archipelago, and the sharp lateral flattening, or "wall-sided" character, of the IIBr series is much more marked. Specimens from Hongkong agree with those from the Philippines in having 38–40 arms and a maximum of 36 cirrus segments.

Localities.—King Island, Mergui Archipelago; Dr. John Anderson [P. H. Carpenter, 1888, 1889; Bell, 1888; A. H. Clark, 1911].

Eighty miles northwest of Penang; 73 meters; Eastern and Associated Telegraph Co.'s cable-ship *Patrol;* taken in May 1923 from a cable laid 2 years previously [A. H. Clark, 1929] (2, B. M.).

Singapore; Svend Gad [A. H. Clark, 1909, 1911] (32, U. S. N. M., 36262, 36263, E. 1076; C. M.).

Singapore; 13 meters; December 12, 1898 [A. H. Clark, 1929] (1, B. M.).

Danish Expedition to the Kei Islands station 73; Sunda Straits (lat. 5°57′S., long. 105°57′ E.); 30 meters; hard bottom; July 28, 1922 (1).

Danish Expedition to the Kei Islands station 101; Java Sea; 49 meters; sand, stones, and sponges; August 5, 1922 (1).

Java Sea, northnortheast of Indramayu Point, Java (lat. 4°56′ S., long. 108°56′ E.); October 23, 1907; Gier 3, Exp. 20 [A. H. Clark, 1933] (1, Buitenzorg Mus.).

Siboga station 322; 1.5 miles south of Tandjong Lajar, south coast of Bawean Island; 32 meters; coral; February 24, 1900 [A. H. Clark, 1918] (1, U. S. N. M., E. 474).

Danish Expedition to the Kei Islands station 38; about 35 meters; sand; April 24, 1922 (2).

Danish Expedition to the Kei Islands; Amboina; breakwater; about 1 meter; February 28, 1922 (3).

Siboga station 162; between Loslos and Broken Islands, western coast of Salawatti; 18 meters; coarse and fine sand, with clay and shells; August 18, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Holothuria Bank, northwestern Australia; 27 meters [A. H. Clark, 1911, 1913] (1, B. M.).

Roebuck Bay (Broome), Western Australia; littoral; H. L. Clark, 1929 and 1932 [H. L. Clark, 1938].

Lagrange Bay, south of Broome, Western Australia; littoral; H. L. Clark, 1929 [H. L. Clark, 1938].

Siboga station 179; Kawa Bay, western coast of Ceram; 36 meters; stony bottom; September 2–3, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Albatross station 5137; in the vicinity of Jolo (Sulu), Philippines; Jolo light bearing S. 61° E., 1.3 miles distant (lat. 6°04′ 25″ N., long. 120°58′30″ E.); 36 meters; sand and shells; February 14, 1908 [A. H. Clark, 1908, 1909, 1911] (2, U. S. N. M., 35142, 35151).

Albatross station 5138; in the vicinity of Jolo; Jolo light bearing S. 19° E., 2.5 miles distant (lat. 6°06′00″ N., long. 120°58′50″ E.); 35 meters; sand and coral; February 14, 1908 [A. H. Clark, 1908, 1909, 1911] (3, U. S. N. M., 35130, 35137).

Off Jolo; about 36 meters; lithothamnion; Th. Mortensen, March 17, 1914 (1).

Albatross station 5358; Jolo (Sulu) Sea; Sandakan light bearing S. 34° W., 19.7 miles distant (lat. 6°06′40″ N., long. 118°18′15″ E.); 53 meters; mud; January 7, 1909 [A. H. Clark, 1911] (1, U. S. N. M., 35149).

Bantayan Reef, Cebu, Philippine Islands; Lawrence E. Griffin (5, M. C. Z., 388, 397; original numbers 69, 70).

Philippines; Prof. C. Semper [P. H. Carpenter, 1888, 1889; A. H. Clark, 1911].

Pulo Condor, Cochinchina; 5 meters; Dr. C. Dawydoff [Gislén, 1936].

Eight miles outside of Hongkong Harbor (lat. 22°12′ N., long. 114°15′ E.); 25 meters; Captain Suenson, November 16, 1911 [A. H. Clark, 1913] (2, U. S. N. M., E. 1078; C. M.).

Hongkong; A. Wieler, 1888 [A. H. Clark, 1912; Mortensen, 1934] (1, H. M.).

Geographical range.—From the Mergui Archipelago to the Lesser Sunda Islands, northwestern Australia, the Moluccas, Salawatti, the Phillippine Islands, and Hongkong.

Bathymetrical range.—From the shore line down to 73 meters.

Occurrence.—Dr. H. L. Clark says that this is a very common species at Broome, and like all the Zygometras of that region it delights in the clean shallow water and hard sandy bottom of Roebuck Bay. At extreme low water in the greatest spring tides, as in September 1929, a large part of the water ebbs out of Roebuck Bay and vast areas of a clean firm gray sand are exposed. On this bottom are countless patches or isolated plants of coralline and other algae, besides partly buried rock fragments or shells scattered abundantly about, well separated from one another, and each forming the nucleus of a little animal community seeking shelter from the pitiless exposure to which the unusual ebb of the tide subjects them. On almost every alga or other projection a comatulid will be found, usually but one, and the vast majority of these are Zygometras, chiefly *comata.* It is a hardy species, enduring this exposure to the sun, transferring to a bucket, and transportation to the laboratory without damaging itself in any way. Left by the retreating tide, the comatulids fall relaxed on their sides, the arms closed on the disk and pointing to the water that has abandoned them. But when the tide returns, enduring for a time the washing back and forth of the now coming, now going, wavelets, they soon find the water deep enough to enable them to sit erect, expand their arms, and renew their normal life. Dr. Clark says that seeing this flowerlike expanding of the wilted comatulids is one of the most interesting pleasures of watching the incoming tide.

History.—In sending some myzostomes taken from a comatulid collected by Dr. John Anderson at King Island in the Mergui Archipelago to Prof. Ludwig von Graff for identification, Dr. P. H. Carpenter gave the name of the host as *Antedon comata.* This name was published as a *nomen nudum* by Professor von Graff in 1887, together with the locality. It was never mentioned again either by von Graff or by Carpenter. Von Graff gave as the locality "Padau Bay in the Mergui Archipelago." Carpenter said (later) that all the comatulids collected by Anderson at Mergui were obtained at one locality, King Island. Therefore Padau Bay, which I can not locate in any of the available books of reference, must be on the shore of King Island, and is possibly the same as King Island Bay, the main anchorage at King Island.

In discussing *Antedon elegans* in the *Challenger* report in 1888 Carpenter said that Professor Semper's Philippine collection contained representatives of the type and that he had recently found a most valuable series of varying forms of this species among the comatulids dredged by Dr. Anderson in the Mergui Archipelago. These Philippine and Mergui specimens represent not *Zygometra elegans* but *Z. comata.* In 1888 Prof. F. Jeffrey Bell mentioned that Dr. Anderson had collected *Antedon elegans* [= *Zygometra comata*] in the Mergui Archipelago.

Under the name *Antedon elegans* Carpenter in 1889 recorded and gave notes upon the five specimens collected by Dr. Anderson at King Island in the Mergui Archipelago. He compared these with the specimens obtained by the *Challenger* and by the *Alert* (representing true *elegans*) and noted the differences. He mentioned a feature exhibited by the Mergui specimens in common with, and more distinct in, others from the Philippines in Semper's collection.

Carpenter said that there were in the collection of comatulids from the Mergui Archipelago three species of "*Antedon*" infested with myzostomes, and that these myzostomes had been placed in the hands of Professor von Graff for identification and description. In his account of the several species, however, he mentioned the presence of myzostomes on only two, *Antedon elegans* and *Antedon milberti*. In von Graff's description of the myzostomes he likewise listed only two comatulids from the Mergui collection among the hosts, *Antedon comata* and *Antedon milberti*. It is thus evident that Carpenter at first believed that the zygometrids collected at Mergui represented a new species, to which he tentatively applied the manuscript name *comata*, but later decided that they should be referred to *Antedon elegans*. The conclusion that the form referred to as *Antedon elegans* in Carpenter's report upon the collection from the Mergui Archipelago is really the one he had originally called in manuscript *Antedon comata* is further borne out by the detailed comparisons he gives between the Australian specimens (representing true *elegans*) and those from elsewhere.

In 1908 I recorded specimens of this species, as *Zygometra elegans*, from *Albatross* stations 5137 and 5138 in the Philippines.

In discussing *Zygometra elegans* in my paper on the comatulids collected by the *Gazelle*, which was published on June 1, 1909, I remarked that I could not agree with Carpenter in regarding *Antedon fluctuans* as a synonym of *Antedon elegans*. I said that "judging from a very large series from Singapore and the Philippine Islands, *fluctuans* has uniformly about thirty arms with wedge-shaped brachials, and comparatively short cirri with not more than thirty-five joints; it is a smaller and more delicate species, with the IIIBr series always 2, developed internally, and bears a very close resemblance to the species of *Heterometra*."

In a memoir on the comatulids in the Zoological Museum of Copenhagen, published on November 16, 1909, under the name *Zygometra fluctuans*, I recorded and gave notes upon 23 specimens from Singapore collected by the Danish Consul, Svend Gad. I said that "these specimens agree closely with Carpenter's description of *fluctuans*, except that the brachials are oblong distally; moreover, they all agree among themselves, and with Philippine specimens." I remarked that I had at first followed Carpenter's lead and considered them, as Carpenter had his own *fluctuans*, to be representatives of Bell's previously described *elegans;* but when I examined the collections made by the *Gazelle* in northwestern Australia I found that I was wrong, for in that collection there are specimens of what is undoubtedly true *elegans* which agree with Bell's diagnosis and have much longer and more robust cirri, composed of more numerous segments, than any of these specimens. I concluded that, judging from the material at hand, *elegans* and *fluctuans* are both perfectly good species, and there is not the slightest difficulty in differentiating them.

In a paper on some crinoids dredged by the *Albatross* in the Philippines published on February 15, 1911, I recorded "*Zygometra comata* (A. H. Clark)" from station 5358, giving the number and length of the arms of the single specimen and remarking that it resembled others from Singapore in the collection of the University of Copenhagen.

In my memoir on the recent crinoids of Australia published later in the same year, in a footnote appended to the differential characters of *Zygometra elegans* I proposed the name *Zygometra comata*, "reinstating a *nomen nudum* long ago applied to it in MS. by Carpenter," for the species represented by the specimens from the Mergui Archipelago, Singapore, and the Philippine Islands, which I had previously considered as representing Carpenter's *Antedon* (*Zygometra*) *fluctuans*. I said that I had found, in working over the magnificent collection of comatulids made at Singapore by Svend Gad, that the common *Zygometra* occurring there and in the Mergui Archipelago is not the same as that called *elegans* by Bell, though it had been united with that species by Carpenter. I gave a few of the characters of the new species and said that a satisfactory description could be found in my report upon the comatulids of the Copenhagen Museum.

In 1912 I recorded and gave notes upon a specimen of *Zygometra comata* from Hongkong that I had examined in the Hamburg Museum in 1910. In my monograph on the crinoids of the Indian Ocean published later in the same year I gave the synonymy of *Z. comata* and its geographical and bathymetrical ranges.

In 1913 I recorded and published notes upon two specimens that had been collected by Captain Suensson, commanding one of the Danish cable repair ships, off Hongkong.

The specimen in the British Museum recorded by me from Holothuria Bank in 1913 under the name of *Zygometra punctata* is probably an example of this species. This is inferred from the notes given on the cirri. The specimen has not been reexamined.

In a memoir on the comatulids collected by the Australian Fisheries Investigations steamer *Endeavour* between Fremantle and Geraldton, Western Australia, published in 1914, I discussed the relationships between *Z. comata* and the other species of the genus.

In the *Siboga* report upon the unstalked crinoids published in 1918, I recorded and described four specimens from three *Siboga* stations, and in 1929 I recorded two specimens from the collections made by the Eastern and Associated Telegraph Co.'s cable repair ship *Patrol*, and another from Singapore.

In 1934 Dr. Th. Mortensen listed *Z. comata* as one of the crinoids occurring at Hongkong.

In 1936 Dr. Torsten Gislén recorded and gave notes upon a specimen collected by Dr. C. Dawydoff at Pulo Condor, Cochinchina.

In 1938 Dr. H. L. Clark recorded and gave extensive notes on 37 specimens from Roebuck Bay and vicinity and 2 from the vicinity of Lagrange Bay collected by himself in 1929 and 1932.

ZYGOMETRA PUNCTATA A. H. Clark

Plate 6, Figures 18–21

Heterometra bengalensis A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 722 (occurs south to Port Curtis), p. 723 (occurs on Holothuria Bank [=*Z. comata*]), p. 734 (in key), p. 768 (synonymy [=*bengalensis*]; characters, in part; Port Curtis [specimen from Holothuria Bank, 15 fathoms = *Z. comata*]; range, in part); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, pp. 440, 443, 444, 446 (Australian records [Holothuria Bank refers to *Z. comata*]); Crinoids of the Indian Ocean, 1912, p. 130 (Queensland [Holothuria Bank refers to *Z. comata*]); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, pp. 310, 313 (all Australian records refer to *Z. punctata* [Holothuria Bank refers to *Z. comata*]).

Zygometra punctata A. H. Clark, Proc. Biol. Soc. Washington, vol. 25, 1912, p. 23 (description; *Siboga* station 273); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 310 (Australian records [Holothuria Bank refers to *Z. comata*]).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 82 (Aru Islands), p. 89 (Aru Islands; Dobo Strait, 50 m.; characters).—A. H. Clark, Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 114 (records [Holothuria Bank refers to *Z. comata*]), p. 123 (comparison with *Z. elegans*); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1915, pp. 224 ff. (detailed account of the distribution [Holothuria Bank refers to *Z. comata*]); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 60 (in key; range), p. 61 (synonymy; detailed description; station 273 [specimen from Holothuria Bank = *Z. comata*]), p. 275 (listed), pl. 19, figs. 40, 41.—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Handl., new ser., vol. 45, No. 11, 1934, p. 21.

Diagnostic features.—The cirri are short and rather stout, strongly recurved in the distal half, with not more than 21 segments of which the longest are about as long as broad. There are 11–21 arms 25–35 mm. in length. The division series are broad, in close lateral contact, with straight lateral edges which are more or less flattened against those of their neighbors. The color—white with numerous circular purple spots on the division series and arm bases and in bandlike areas on the outer portions of the arms—and the conspicuously banded white and purple cirri seem to be quite distinctive. But it is always unsafe to rely too much on color when dealing with comatulids.

This species is much more likely to be confused with the young of certain species of *Heterometra* than with the other species of *Zygometra*. It is easily distinguished from these, however, by the syzygy between the elements of the IBr series.

Description.—The centrodorsal is discoidal, thin, with a broad, flat, circular dorsal pole 2.7 mm. in diameter.

The cirri are XV, 18–19 (usually 18), 9 mm. long. The first segment is very short, the second and third are about three times as broad as long, the fourth is about twice as broad as long, and the fifth or sixth is about as long as broad. The next two or three segments are similar and those following decrease very gradually in length so that the outermost 10 or 11 are slightly broader than long. The sixth and following segments bear prominent sharp dorsal spines.

The radials are entirely concealed by the centrodorsal. The IBr_1 are very short and bandlike, six or more times as broad as long, united to the IBr_2 by syzygy. The IBr_2 (axillaries) are low triangular with the lateral angles slightly truncated, three times as broad as long. There are 9 IIBr series present, 8 of which are 4 (3+4) and one of which is 2. A single IIIBr series of two elements is developed internally on one of the IIBr 4 (3+4) series. The IIBr series are broad like the IBr series with straight lateral edges which are more or less flattened and almost or quite in apposition. The lateral outer portions of the elements of the division series are roughened or very finely papillose as in certain species of *Mariametra*.

The 21 arms are 35 mm. long and are comparatively short and rather stout. The first brachials are slightly wedge-shaped, three times as broad as the median length, and are entirely united internally. The second brachials are much more obliquely wedge-shaped, twice as broad as the external length. The first syzygial pair (composed of brachials 3+4) is slightly longer internally than externally, and twice as broad as long internally. The next three brachials are oblong, three to four times as broad as long, and those following are wedge-shaped, twice as broad as long, becoming as long as broad terminally. The brachials have rather strongly produced distal edges.

P_D resembles P_1 and is composed of 20 segments. P_1 is about 5 mm. long, rather stout basally but in the distal half tapering to a slender tip, and is composed of 20 segments of which the first is about three times as broad as long, and those following gradually increase in length becoming as long as broad on the ninth and slightly longer than broad terminally. The longer proximal segments are rather strongly carinate, the carination having a straight profile which is parallel with the long axis of the segments. The short outer segments have slightly prominent distal ends. P_2 is similar, but very slightly smaller and shorter. P_3 is 2.5 mm. long, composed of 12 segments; except for its smaller size it is similar to the preceding pinnules. P_4 is 2 mm. long, with 12 segments, of which the first three are much broader than long, the fourth is about as long as broad, and the distal are twice as long as broad. P_5 is 2.5 mm. long, with 12 segments, and resembles P_4, but it is very slightly stouter basally and the distal segments are longer. The following pinnules resemble P_5. The distal pinnules are 4 mm. long, with 15 segments, of which the distal are nearly or quite three times as long as broad.

The color in alcohol is white with numerous regular purple spots on the division series and arm bases and in bandlike areas on the distal portions of the arms. The cirri are white with a band of purple on each segment.

Notes.—A specimen from *Siboga* station 273, which is similar to the type, has 17 arms, with 5 IIBr 4 (3+4) series and 2 IIBr 2 series; the cirri are XVII, 18, 9 mm. long. The remaining two specimens from this station are small.

Reichensperger referred to this species a 10-armed young individual from the Aru Islands. The 10 graceful, slender arms are 27 mm. long. The centrodorsal is thin, with the cirri arranged in a single irregular row. The cirri are XV, 13–15, up to 5 mm. in length. The first segment is short and laterally compressed, the second is noticeably longer than broad, and the third, fourth, and fifth are the longest, about twice as long as broad. The length of the segments then decreases slowly so that the last is broader than long. The opposing spine is very long and straight. The terminal claw is about twice as long as the penultimate segment, long and strongly curved. From the fourth or fifth segment onward strong dorsal spines are developed. P_1 is 4 mm. long, with 20–22 segments, of which the first is broader than long, the next 10 or so are about as long as broad, and the remainder slightly elongated, the pinnule becoming flagellate terminally. P_2 is 3.5 mm. long, with about 18 segments, and resembles P_1. P_3 is scarcely 2 mm. long and is composed of 11 or 12 segments. P_4 is the shortest, about 1.5 mm. long, moderately stout, with 8 or 9 segments. The following pinnules increase in length and in the number of their component segments. P_5 has 12 segments. The distal pinnules are about 3 mm. long. The IBr series are rather short, and laterally free. The brachials are relatively long, with the ends only slightly oblique. The lowest brachials bear slight ventrolateral processes. The disk is lacking. The color in life was light red.

Of the three specimens from Port Curtis one has 12 and two have 11 arms, 25 mm. to 33 mm. long. The cirri of the largest specimen are XV, 14–18 (usually 15).

Localities.—*Siboga* station 273; anchorage off Pulu Jedan, eastern coast of the Aru Islands (pearl banks); 13 meters; sand and shells; December 23–26, 1899 [A. H. Clark, 1912, 1913, 1918] (4, U. S. N. M., E. 442; Amsterdam Mus.).

Aru Islands; Dr. H. Merton's station 4; Dobo Strait; 50 meters; calcareous rock; March 20, 1908 [Reichensperger, 1913].

Port Curtis, Queensland [A. H. Clark, 1911, 1913] (3, U. S. N. M., 35150; Australian Mus.).

Geographical range.—Aru Islands and the northern coasts of Australia south to Port Curtis, Queensland.

Bathymetrical range.—Littoral and sublittoral; from the shoreline down to 50 meters.

History.—This species was first mentioned in my monograph of the recent crinoids of Australia, published in 1911, under the name of *Heterometra bengalensis*. The three small specimens from Port Curtis referred to *Heterometra bengalensis* represent this species, but the one from Holothuria Bank in the British Museum is in reality an example of *Zygometra comata.*

In 1912 *Zygometra punctata* was described as a new species on the basis of a specimen from *Siboga* station 273. In 1913 in a supplementary paper on the crinoids of southwestern Australia all of the Australian records of *Heterometra bengalensis* were referred to this species.

In a paper on the crinoids in the British Museum published in 1913, *Zygometra punctata* was recorded from Holothuria Bank. The specimen from Holothuria Bank is in reality, however, *Z. comata.* It was this specimen that served as the basis for all the records from Holothuria Bank in both earlier and later papers.

In 1913 Dr. August Reichensperger described a young 10-armed specimen from the Aru Islands.

In the *Siboga* report published in 1918 this species was redescribed and figured, and another specimen from station 273 was mentioned. Holothuria Bank was again erroneously included in the range. Dr. Hubert Lyman Clark's *Heterometra delicata*, based upon a single specimen that he had found on the sand flat on the southern end of Friday Island, Torres Strait, was included in the synonymy of this species. This is an error, as the type specimen of *Heterometra delicata* is a young specimen of some species of *Heterometra.*

ZYGOMETRA PRISTINA A. H. Clark

PLATE 7, FIGURES 22, 23

Zygometra pristina A. H. CLARK, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 537 (description; *Albatross* station 5276); Crinoids of the Indian Ocean, 1912, p. 106 (synonymy; habitat).—REICHENSPERGER, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, pp. 91, 92 (comparison with *Z. mertoni* [=young *Z. microdiscus*]).—A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 60 (in key; range).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 17, 18.

Diagnostic features.—The possession of only 10 arms and the partially developed syzygy between the elements of the IBr series distinguish this species at once from all the others in the genus. The arms are 50 mm. long. The cirri are XII, 20–21, 12 mm. long, with the longest segments about one-third again as long as broad.

Description.—The centrodorsal is low hemispherical with the bare polar area papillose, 1 mm. in diameter. The cirrus sockets are arranged in a single irregular not especially crowded row.

The cirri are XII, 20–21, 12 mm. long, and moderately slender. The first segment is short, the following gradually increasing in length and becoming about one-third again as long as broad on the fourth. The next two segments are similar, and those succeeding slowly decrease in length, those in the outer part of the cirri being about as long as broad. The sixth or seventh and following segments bear long sharp dorsal spines. The opposing spine is nearly as long as the width of the penultimate segment, and is slender, sharp, and erect. The terminal claw is twice as long as the penultimate segment and is strongly curved proximally, becoming straighter distally. The cirrus segments are somewhat constricted centrally with slightly expanded and overlapping distal ends.

The disk is covered with rounded isolated flat plates and is thickly plated along the ambulacral grooves and on the anal tube.

The radials are short, about four times as broad as long, sometimes with a faintly marked row of small tubercles along the distal border.

The IBr_1 are about as long as the radials, oblong, four times as broad as long. The IBr_2 (axillaries) are pentagonal, twice as broad as long. The elements of the IBr series are united by a curious syzygy (pseudosyzygy) in which the outer portion of the joint face for about one-half the distance from the periphery to the rim of the central canal is marked with radiating ridges, the space within this border being smooth and flat except for the low and narrow synarthrial longitudinal ridge.

The 10 arms are 50 mm. long. The first two brachials are subequal, slightly wedge-shaped, twice as broad as the exterior length. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly, and twice as broad as the exterior length. The next four brachials are oblong, slightly over twice as broad as long, and those following become obliquely wedge-shaped, about as long as broad, after the proximal third of the arm less obliquely wedge-shaped and about as long as broad, and terminally slightly longer than broad. The brachials after the tenth have somewhat produced distal ends.

Syzygies occur between brachials 3+4, again most commonly between brachials 13+14, and distally at intervals of 6–10 (usually 8 or 9) muscular articulations.

P_1 is 8 mm. long, moderately stout basally but tapering rapidly in the proximal half and becoming very slender and thread-like distally, with about 25 segments of which the first is about twice as broad as long and those following gradually increase in length becoming about as long as broad on the fifth and following and slightly longer than broad terminally. The first three to five segments are slightly carinate and rounded prismatic. P_2 is about 10 mm. long, stouter than P_1 but otherwise similar to it, with about 30 segments. P_3 is 3.5 mm. long, small, weak, and slender, and becoming exceedingly slender in its distal half. P_4 is similar, 3 mm. long. P_5 is 2 mm. long, not tapering so rapidly as the preceding pinnules and therefore appearing somewhat stouter, with 10 segments. The following pinnules are similar, soon slowly increasing in length and slenderness. The distal pinnules are very slender, 6 mm. long, with 15 or 16 segments.

Locality.—*Albatross* station 5276; China Sea, in the vicinity of southern Luzon; Malavatuan Island (N. W.) bearing N. 61° 30′ E., 6.5 miles distant (lat. 13°49′15″ N., long. 120°14′45″ E.); 33 meters; shells, pebbles and sand; July 17, 1908 [A. H. Clark, 1911, 1912, 1918; Reichensperger, 1913] (1, U.S.N.M., 27489).

Remarks.—This species is as yet known only from the single specimen dredged by the *Albatross* in 1908.

Genus CATOPTOMETRA A. H. Clark

Antedon (part) A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1907, pp. 72, 150.

Zygometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, pp. 339, 345, 347.

Catoptometra A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 317 (listed, with 3 species mentioned, *hartlaubi*, *koehleri*, and *rubroflava;* in family Zygometridae; no diagnosis and no type designated), p. 505 (type designated as *Antedon hartlaubi* A. H. Clark, 1907); vol. 35, 1908, fig. 16, p. 119 (arm structure); Smithsonian Misc. Coll., vol. 52, 1908, p. 217 (characteristic rough feeling of arms); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 2 (cirri and lower pinnules compared with those of Charitometridae); Vid. Medd. Naturh. Foren. København, 1909, p. 152 (cirri and brachials compared with those of *Zygometra fluctuans* [*comata*]), p. 193 (probably occurs at Singapore though not yet discovered there); Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 129 (characteristic of the Japanese fauna; significance); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); Crinoids of the Indian Ocean, 1912, p. 9 (absent from Australia), p. 10 (great development of local species in Japan), p. 11 (absent from west coast of Malay Peninsula and from farther west), p. 17 (significance of conditions in this genus in southern Japan), p. 21 (range; reaches to 153 fathoms), p. 56 (in key), p. 106 (original reference; type); Die Crinoiden der Antarktis, 1915, p. 112 (synonymy; range); Amer. Journ. Sci., vol. 40, 1915, p. 62 (list of recent species), p. 63 (number of recent and fossil species; range), p. 65 (confined in recent seas to the western Pacific; fossil in Patagonia and Europe).—F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Pap. 90–L, 1915, p. 195 (inorganic constituents of the skeleton); Professional Paper 102, 1917, pp. 23 and following (same).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 63 (key to the included species); Univ. Iowa Stud. Nat. Hist., vol. 9, No. 5, 1921, p. 14 (includes both recent and fossil species; not known from West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 17.—F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Pap. 124, 1922, p. 20 (inorganic constituents of the skeleton).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 64; Zool. Bidrag Uppsala, vol. 9, 1924, pp, 35, 84, 100, 107, 117, 159; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.

Diagnosis.—A genus of Zygometridae in which the outer cirrus segments are but little, if at all, shorter than the proximal and do not bear dorsal processes.

Geographical range.—Southern Japan from the Korean Straits to Sagami Bay, the Bonin and Philippine Islands, Hong Kong, and southward to the Lesser Sunda Islands.

Bathymetrical range.—From 25 to 914 meters; most abundantly represented between 81 and 196 meters.

Remarks.—The genus *Catoptometra* is one of the most easily recognized of all the genera of multibrachiate comatulids. The stout strongly recurved smooth cirri with more or less swollen articulations and consequently a knobby appearance, combined with the presence of a syzygy between the elements of the IBr series, separate it at once from all other genera including multibrachiate forms. The syzygy in the IBr series is very brittle, and almost invariably during capture one or more of the postradial series—not infrequently all—are broken across at this point.

Superficially the species of *Catoptometra* resemble to a certain extent some of the species in certain genera of Charitometridae, but these last are easily recognized by the sharply carinate pinnules and the occurrence of conspicuous side plates and covering plates on the ventral surface of the pinnules.

Of the four species included in the genus one, *C. hartlaubi*, seems to occupy a rather isolated position. The other three are more closely allied, but one of these, *C. magnifica*, differs markedly from the others in having all the division series of two ossicles only and in having a greater number of arms. The two remaining species, *C. rubroflava* and *C. ophiura,* seem to be very closely related, though on the basis of our present knowledge they are quite distinct.

One species, *C. magnifica,* has a very extensive range, occurring from southwestern Japan and the Bonin Islands to the Lesser Sunda Islands; two species, *C. hartlaubi* and *C. rubroflava,* occur only in southern Japan, the latter ranging south to Hongkong; and the fourth species, *C. ophiura,* is found only from the Lesser Sunda Islands to the Philippines.

Though occurring in rather shallow water, the species of *Catoptometra* live at a greater depth than the species of *Zygometra,* the upper limits of the former slightly overlapping the lower limits of the latter.

History.—The generic name *Catoptometra* was first used in a list of the crinoids of Japan published July 15, 1908. No diagnosis was given. Three species were mentioned, *Catoptometra hartlaubi, C. koehleri,* and *C. rubroflava.* In another paper published in the same volume on August 25, 1908, the genus *Catoptometra* was listed and the type species was given as *Antedon hartlaubi* A. H. Clark, 1907. No diagnosis was published until 1912, when it was inserted in a key to the genera of the family Zygometridae and the characters separating it from *Zygometra* were given. The question whether the endocyclic comatulids with a syzygy in the IBr series and smooth cirri should retain the name *Catoptometra,* or assume the unfamiliar name *Zygometra,* has already been discussed (see page 81).

KEY TO THE SPECIES IN THE GENUS CATOPTOMETRA

a^1. Arms 30–80 in number; all division series 2 (southwestern Japan, Bonin Islands, and Philippines to southern Annam and Lesser Sunda Islands; 36–914 meters).......... **magnifica** (p.126)

a^2. Less than 30 arms; IIBr series 4 (3+4).

  b^1. Cirri short and stout, few or none of segments longer than broad; 11–14 arms; in life broadly banded with bright red and bright yellow (southern Japan from Sagami Bay to Korean Straits and southward to Hongkong; 25–183 meters)................ **rubroflava** (p.133)

  b^2. Cirri longer and less stout, longest segments being twice as long as median width; 20 or more arms.

    c^1. Arms 20–23 in number; cirrus segments 14–17 (usually 14 or 15); elements of division series and first two brachials with prominently everted and produced spinous distal edges; dorsal pole of centrodorsal papillose or finely spinous; color in life uniform, brown or greenish (southern Japan from Sagami Bay to Korean Straits; 137 [?115] – 278 meters) **hartlaubi** (p. 139)

    c^2. Arms 20–27 in number; cirrus segments 15–19 (usually 17–19); elements of division series and arm bases smooth; dorsal pole of centrodorsal smooth; color in life usually dark green, rarely red and yellow (from Lesser Sunda Islands to Philippines; 69–106 meters)— **ophiura** (p. 136)

CATOPTOMETRA MAGNIFICA A. H. Clark

Plate 7, Figures 24, 25; Plate 8, Figure 26; Plate 9, Figure 31

Catoptometra magnifica A. H. Clark, Smithsonian Misc. Coll., vol. 52, 1908, p. 208 (description; *Albatross* station 5137); Crinoids of the Indian Ocean, 1912, p. 106 (synonymy; habitat); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 63 (in key; range).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 67 (compared with *C. m. minor*).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p 637 (off Cape Padaran, 80 fathoms; Rotti Strait, 100 fathams.).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 33; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 2 (southern Annam), p. 4 (French Indochina), p. 6 (range).

Catoptometra magnifica var. *minor* Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 4 (127–182 m.), p. 65 (description; Bock's stations 46, 47, 59, 61), p. 67 (also in Mortensen's collection), figs. 46, 47, p. 70; Vid. Medd. Dansk Naturh. Foren., vol. 83, 1927, p. 2 (stations 10, 13, 24, 26; 109–900 m.), p. 20 (stations 10, 13, 24, 26; notes), pp. 68, 69 (listed).

Catoptometra magnifica minor Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 6 (Bonin Islands), p. 8, p. 27 (tabulation of characters), pp. 182, 183 (listed), figs. 46, 47, p. 70; Zool. Bidrag Uppsala, vol. 9, 1924, p. 71 (nonmuscular articulations), p. 74 (syzygies), p. 285 (Kiu Shiu, Japan, 900 m.; details), p. 286, fig. 59, p. 75 (syzygial face); Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 24.

Diagnostic features.—All the division series are of two ossicles only, and the arms are more than 30 in number. The cirri are long, stout, recurved, and knobby, composed of 18–25 segments and reaching 30–35 mm. in length. The arms are 130–140 mm. long.

Specimens from the Philippines were apparently in life bright yellow with regular bands of bright red on the arms. They were readily distinguished by this coloration from the species with which they were associated. But *Catoptometra rubroflava* always and *C. ophiura* sometimes is of the same color, while it is not certain that this species is constant in its coloration.

Description.—The centrodorsal is discoidal, large, with a broad polar area 5 to 10 mm. in diameter, which is moderately concave with a deep rounded pit in the center. The cirrus sockets are arranged in two closely crowded and irregular more or less alternating rows.

The cirri are XXX–XL, 18–25 (usually 20–24), 30–35 mm. in length, stout and knobby in appearance. The first segment is about twice as broad as long, the second is not quite so long as broad, the third is about as long as broad or very slightly longer than broad, the fourth is slightly longer, and the fifth is slightly longer still, about half again as long as its median width. The next three segments are similar to the fifth and those following gradually decrease in length so that the terminal six or seven are about as long as broad. The opposing spine, though prominent, is small, terminally situated, rarely reaching to more than one-third the width of the penultimate segment in length. The terminal claw is large, longer than the penultimate segment, usually half again as long and sometimes even longer, stout and moderately curved. The lateral and dorsal profiles of the cirrus segments are deeply concave, though the ventral profile is nearly straight. This causes the articulations to stand out prominently and gives the cirri a characteristic appearance, like those of *C. rubroflava.* This feature becomes less and less marked as the segments decrease in length distally.

The disk is more or less plated along the ambulacral grooves.

The radials, and usually also the IBr_1, are concealed by the centrodorsal. When visible the IBr_1 are very short and are united in their proximal half but widely separated distally. The IBr_2 (axillaries) are short, triangular, in the smaller specimens about three times as broad as long, in the larger four or five times as broad as long. The IIBr, IIIBr, and IVBr series are 2. The first ossicles following each axillary are interiorly united for their proximal half, but their distal halves diverge from the point of union almost in a straight line so that the division series and the arms are well separated.

The arms are 20–80 (ussally 30–40) in number, 140 mm. long. The first brachials are usually rather large, sometimes nearly as long exteriorly as broad, interiorly united in the proximal half, diverging in almost a straight line in the distal. There is a considerable diversity in size, some first brachials being very short, while most of them are about twice as broad as long exteriorly. The second brachials are nearly oblong, about twice as broad as long. The first syzygial pair (composed of brachials 3+4) is oblong, somewhat less than twice as broad as long. The next six or seven brachials are oblong, about twice as broad as long, those following becoming wedge-shaped and then almost triangular, about twice as broad as long, and slowly less and less obliquely wedge-shaped and very gradually increasing in length so that the terminal brachials are wedge-shaped, about as long as broad or rather longer, with rather prominent articulations. The second and following brachials have projecting and finely spinous distal edges.

Syzygies occur between brachials 3+4, again from between brachials 13+14 to between brachials 17+18 (with rarely an additional one between brachials 9+10), and distally at intervals of from 3 to 13 (usually 6–8) muscular articulations.

The lower pinnules are very slender and flagellate. P_1 is 15 to 20 mm. in length, very delicate, with about 60 segments of which the first five are broad and are provided with a dorsal carinate process and the remainder are about as long as broad. P_2 is longer, about 22 mm. in length, and slightly stouter, with the same number of segments of which the first five are modified as in P_1 and the remainder are about as long as broad. P_3 is similar to P_2 and is of about the same length. The following pinnules decrease gradually in length, in basal stoutness, and in the number of their component segments, P_6 being 12 mm. long with 30 segments of which those in the proximal third are similar to those of the second and third pinnules, and those in the distal portion are longer than broad, becoming about twice as long as broad terminally, and P_{12} being 8 mm. long, with about 20 segments, of which the first two are not quite so long as broad, the third and fourth are about as long as broad, and the following become progressively elongated and about twice as long as broad distally. The distal pinnules are very slender, 9 mm. long with about 30 segments of which the first is wedge-shaped, not so long as broad, the second is trapezoidal, about as long as its greater width, the third is longer than broad, and the remainder are about twice as long as broad. The pinnule segments have slightly projecting and very finely spinous distal ends.

Notes.—The larger of the two specimens from Rotti Strait is rather small and slender, with about 30 arms, which are about 130 mm. long; the arms are arranged in 2, 1, 1, 2 order. The other specimen from Rotti Strait is very small and much broken; it is apparently undergoing adolescent autotomy.

The specimen from the Danish Expedition to the Kei Islands station 27 is young with 14 very slender arms 70 mm. long. One ray bears one IIBr series, which carries 2 IIIBr series, and another ray has one IIBr series.

The specimen from off southern Annam is a slender example with about 20 arms, about 130 mm. long. The longest cirri have 22 or 23 segments. The two youngest cirri, at the periphery of the centrodorsal, differ from the others in lacking the strongly produced and everted distal ends of the segments, which gives them quite a distinctive aspect; they are also not so strongly curved as are the other cirri.

Of the five specimens from south of the Goto Islands one has 38 arms 180 mm. long; there are several slender cirri with no expansion of the ends of the segments. Another has 34 arms 135 mm. long; the lateral borders of the division series have rather numerous fine tubercles. The cirri are XLV, 19–20 (usually 20), about 30 mm. long. Among the cirri there is a single one 18 mm. long with 18 segments that is slenderer than the others, scarcely at all curved, in which the component segments do not have expanded ends. The centrodorsal is 6 mm. in diameter, with the dorsal pole slightly concave. A third specimen has 33 arms 135 mm. long. All the division series are 2. The second and third segments of the first seven or eight pinnules bear a very high carinate process, and the fourth and sometimes the fifth carry a much smaller carinate process. The lateral edges of the elements of the division series have a few small tubercles. The centrodorsal is discoidal with the broad dorsal pole slightly concave, 5 mm. in diameter. The cirri are XXXIII, 19–23 (usually 22). Another example has about 30 arms 140 mm. long. The outer portion of the proximal and distal edges of the elements of the division series are swollen and more or less beaded, and the lateral edges bear small tubercles. The fifth specimen is small, with 25 arms.

In the specimen from Mortensen's station 10 the cirri are XXX, 19–23, from 17 to 25 mm. long. The IIBr and IIIBr series are 2, the latter being externally developed. The division series have well-developed ventrolateral tubercles, 1 to 3 on each segment. The 29 arms are about 100 mm. long. There are 14 brachials to each 10 mm., or 13 if the syzygial pairs are counted as units. The distal intersyzygial interval is 14–19 muscular articulations. P_1 is 7 mm. long, with about 30 segments. P_2 is 13 mm. long, with 37 segments. P_3 is composed of 33 segments. P_4 is about 10 mm. long. The distal pinnules are 11 mm. long, with about 25 segments. The disk is lacking.

In one of the specimens from Mortensen's station 13 the cirri are XXXIII, 22–25, from 20 to 30 mm. long. The centrodorsal is 8 mm. in diameter, with the concave dorsal pole 7 mm. across. The 35 arms are 80+ mm. long. There are two IVBr 2 series. In another specimen from Mortensen's station 13 the cirri have 19–25 segments. There are 26+ (probably 30) arms 80 mm. long. The disk is incised, 8 mm. in diameter with the anal tube 3 mm. high. In a third specimen two postradial series bear six and four arms, the three other postradial series being broken away. In the fourth specimen from station 13 the cirri have 19–21 segments. There are 22 arms 90+ mm. long.

In the specimen from Mortensen's station 24 the cirri are XXX, 22–25, from 21 to 27 mm. long. The 26 arms are 110 mm. long. The distal intersyzygial interval is 4–11 (usually 8) muscular articulations. P_1 is 8 mm. long, with 25 segments. P_3 is 11 mm. long, with 33 segments. P_5 is 10 mm. long, with 24 segments. The distal pinnules are 9 mm. long, with 22 segments. The first 10 pinnules have the usual characteristic processes on the proximal segments. The disk, which is detached, is incised and measures 12 mm. in its longest and 8 mm. in its shortest diameter. The perisome contains calcareous granules.

The species is represented from Mortensen's station 26 by detached arms and groups of arms. The arm length is 125 mm.

The specimen from Bock's station 46 is young, with 12 arms 35–40 mm. long. The arms are slender, and the brachials are smooth, rather long, and slightly constricted centrally. The arm bases are well separated, leaving broad strips of the perisome visible. The radials are rounded, smooth, and distally well separated laterally. The IBr_1 are three times as broad as long. The IBr_2 (axillaries) are twice as broad as long. The IIBr series are 2, both being young regenerates. The centrodorsal is almost completely concealed by the cirri. The cirri are XXIII, 10–14, from 3 to 7 mm. in length. The first segment is short, the second is about as long as broad and is centrally constricted, the third is half again as long as broad, and the fourth is twice as long as broad and is strongly constricted centrally. The succeeding segments are shorter, and the antepenultimate is one-quarter again as long as broad. The height of the opposing spine is equal to one-third the width of the segment bearing it. The terminal claw is a little shorter than the penultimate segment. P_1 is 4 mm. long, with 22 segments. P_2 is 4.2–5.5 mm. in length, with 20 segments. P_3 is 4.3 mm. long, with 19 segments. P_4 is 3.8 mm. long, with 15 segments. P_6 is 3 mm. long. The length of the distal segments is twice the breadth. The basal segments have weak prominences. The distal pinnules are 5 mm. long, with 18 segments which are very long, being four to five times as long as broad. The disk is incised and bears calcareous granules along the ambulacral furrows. The anal cone is long and narrow, 1.5 mm. high.

The three specimens from Bock's station 47 are all young. In one the IBr_1 are twice as broad as long. The distal intersyzygial interval is three or four muscular articulations. In another the IBr_1 are one-quarter again as broad as long. The distal intersyzygial interval is 4–8 muscular articulations. In the third the IBr_1 are twice as broad as long. The distal intersyzygial interval is six muscular articulations. P_6 is 3.5 mm. long with 14 segments. The disk is "lean" and incised, 2–3 mm. in diameter. The anal funnel is 1.5 mm. high.

In one of the specimens from Bock's station 59 the centrodorsal is flat with the free dorsal pole granular, 3.5 mm. in diameter. The cirri are XXV, 20–21, from 17 to 22 mm. long, arranged in a partially double marginal row. The first and second segments are short, the third is about as long as broad, the fourth is a little longer, and the fifth and sixth are about one-third again as long as the distal width. The length of the following segments slowly decreases. The proximal segments are constricted centrally with their distal ends especially broadened. The antepenultimate segment is one-quarter again as long as broad. The opposing spine is inconspicuous, its height being equal to one-quarter the width of the segment which bears it. The terminal claw is pointed, and is about as long as the penultimate segment. The radials are partly concealed by the centrodorsal and are visible only as very narrow bands. The IBr_1 are four times as broad as long and are free laterally. The IBr_2 (axillaries) are low pentagonal, three times as broad as long. The IIBr and IIIBr series are 2. The 24 arms are all broken. The first 10 brachials are discoidal, and those following have oblique ends that are somewhat overlapping and are armed with small spines. There is a weak synarthrial tubercle on the articulation between the first and second brachials. Syzygies occur between brachials 3+4, 8+9, and 14+15 and distally at intervals of 4 or 5 muscular articulations. P_1 is 5.5 mm. long, with 22 segments. P_2 is about 10 mm. long, with 36 segments. P_3 is 13 mm. long, with 40 segments. P_5 is about 9 mm. long, with 29 segments. P_{10} is 6 mm. long, with 15 segments. P_1 to about P_7 have the first-fifth or -sixth segments provided with large prominences, which in height are equal to from one-third to one-fourth the width of the segments. The distal pinnules are 6 mm. long, with about 20 segments. The proximal segments are distally somewhat serrate and broadened. The disk is incised and measures 13 mm. in its longest and 8 mm. in its shortest diameter. It bears fine calcareous granules. The mouth is central.

A second specimen from Bock's station 59 has the centrodorsal as in the preceding, 4 mm. in diameter, with the dorsal pole studded with small papillae and 3 mm. across. The cirri are XXIV, 15–19, from 9 to 11 mm. long. The height of the opposing spine equals one-third that of the segment which bears it. The IIBr and IIIBr series are 2. The arms, which are partly broken, are 21 (with perhaps 2 more) in number and 60 mm. long. The IBr_1 are three times as broad as long. The lateral borders of the IBr and IIBr series are slightly spiny. The intersyzygial interval is four or five muscular articulations. P_1 is 3.5 to 4 mm. long, with 22–24 segments. P_2, on a regenerating arm, is 5 mm. long, with 25 segments. P_4 is 6 mm. long, with 22 segments. Only the first three pinnules are carinate. The distal pinnules are 4.5 mm. long, their segments being three times as long as broad. The disk is 6 mm. in diameter, and the anal cone is 1.7 mm. high.

In the third specimen from Bock's station 59 the centrodorsal is 5 mm. in diameter, with the radially furrowed dorsal pole 3.5 mm. in diameter. The cirri are XXII, 19–20, from 16 to 18 mm. long, and are arranged in a double row. The IBr_1 are eight times as broad as long and are free laterally. The IBr_2 (axillaries) are three times as broad as long. One of the IIBr series is 3, without a pinnule; the other IIBr series and the IIIBr series are all 2. The 23 arms are all broken. The proximal ossicles of the division series have three or four small lateral tubercles, which on the IBr_1 ornament the whole proximal margin. A similar, though less distinct, ornamentation occurs on the $IIBr_1$ and on the $IIIBr_1$. The ossicles immediately following the axillaries are interiorly united as far as the distal third. P_1 is about 5 mm. long, with 25 segments. The disk is incised and measures 12 mm. in its longest and 6 mm. in its shortest diameter. Gislén notes that this specimen differs from the two others from Bock's station 59 in its lighter color and in the ornamentation of the proximal ossicles.

The specimen from Bock's station 61 is young. The IBr_1 are twice as broad as long. The intersyzygial interval is 5–7 muscular articulations. Gislén noted that in this, as in the specimen from station 46 and the three from station 47, the prominences on the proximal pinnules are indiscernible.

Localities.—Rotti Strait, between Rotti and Timor; 183 meters; from the Banjuwangi–Darwin No. 2 cable; cable repair ship *Cable*, Eastern and Associated Telegraph Co. [A. H. Clark, 1929] (2, B. M.).

Danish Expedition to the Kei Islands station 27; 60–70 meters; fine sand; April 17, 1922 (1).

Off Cape Padaran, southern Annam (lat. 11°38′N., long. 109°41′E.); 146 meters; from the Cape St. James–Hongkong cable; R. H. Ellis, cable repair ship *Patrol*, Eastern and Associated Telegraph Co., June 4, 1927 [A. H. Clark, 1929] (1, B.M.).

Albatross station 5137; in the vicinity of Jolo (Sulu), Philippines; Jolo light bearing S. 61° E., 1.3 miles distant (lat. 6°04′25″ N., long. 120°58′30″ E.); 36 meters; sand and shells; February 14, 1908 [A. H. Clark, 1908, 1912, 1915, 1918; Gislén, 1922] (1, U.S.N.M., 25436).

Albatross station 5139; in the vicinity of Jolo; Jolo light bearing S. 51° W., 3.6 miles distant (lat. 6°06′ N., long. 121°02′30″ E.); 36 meters; coral sand; February 14, 1908 [A. H. Clark, 1908, 1912, 1915, 1918; Gislén, 1922] (1, U.S.N.M., 35172).

Korean Straits, south of the Goto Islands (lat. 32°15′ N., long. 128°20′ E.); 183 meters; Capt. H. Christiansen, April 17, 1926 (5).

Dr. Th. Mortensen's Expedition to Japan station 10; off the Goto Islands (lat. 33°41′ N., long. 128°50′ E.); 137 meters; sand; May 17, 1914 [Gislén, 1927].

Dr. Th. Mortensen's Expedition to Japan station 13; Korean Straits, east of Tsushima (lat. 34°20′ N., long. 130°10′ E.); 110 meters; sand and shells; May 18, 1914 [Gislén, 1927].

Dr. Th. Mortensen's Expedition to Japan station 24; Sagami Bay; 914 meters; June 26, 1914 [Gislén, 1927].

Dr. Th. Mortensen's Expedition to Japan station 26; Sagami Bay, off Okinose; 366 meters; hard bottom; July 1, 1914 [Gislén, 1914].

Dr. Sixten Bock's Expedition to Japan station 46; Bonin Islands, east of the Channel; 128 meters; August 1, 1914 [Gislén, 1922, 1924].

Dr. Sixten Bock's Expedition to Japan station 47; Bonin Islands, east of the Channel; 146 meters; August 1, 1914 [Gislén, 1922, 1924].

Dr. Sixten Bock's Expedition to Japan station 59; eastnortheast of Anojima, Bonin Islands; 183 meters in published record, 150 meters on label of specimen examined; August 15, 1914 [Gislén, 1922, 1924] (1, U.S.N.M., E. 1114).

Dr. Sixten Bock's Expedition to Japan station 61; Bonin Islands, eastsoutheast of the Channel; 152 meters; August 16, 1914 [Gislén, 1922, 1924].

Geographical range.—From the Lesser Sunda Islands and southern Annam to the Philippines, southern Japan, and the Bonin Islands.

Bathymetrical range.—From 36 to 914 meters; the average of 14 records is 188 meters.

History.—This species was originally described in 1908 from specimens collected by the *Albatross* in the Philippines earlier in the same year.

In 1922 Dr. Torsten Gislén recorded and gave notes upon eight specimens dredged by Dr. Sixten Bock in the Bonin Islands and southwestern Japan and mentioned incidentally that there were other specimens in Dr. Th. Mortensen's Japanese collection. He found that the specimens from the Bonin Islands and southern Japan included in Bock's and Mortensen's collections differed from *C. magnifica* as originally described in having fewer arms, shorter cirri, and very much shorter proximal pinnules. He therefore proposed that they be recognized as representing a new variety, which he called *minor.* As in many species of crinoids individuals from certain localities in the Philippines and from some other localities in the East Indies are considerably larger with more numerous arms than those from elsewhere, it does not seem advisable, at least for the present, to recognize this new variety.

In 1927 Gislén recorded and gave notes upon the six specimens in Mortensen's collection from southern Japan, referring them to his new variety *minor.*

CATOPTOMETRA RUBROFLAVA (A. H. Clark)

Plate 8, Figure 27; Plate 9, Figures 30, 33

Antedon rubroflava A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1907, p. 127 (color in life), p. 150 (description; *Albatross* station 4880), p. 151 (comparison with *A.* [*Catoptometra*] *hartlaubi*); vol. 34, 1908, p. 493 (listed).

Zygometra rubroflava A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 348 (listed); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 271 (relation to the species of *Eudiocrinus*).

Catoptometra rubroflava A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 317 (listed); Smithsonian Misc. Coll., vol. 52, 1908, p. 210 (compared with *C. magnifica*); Vid. Medd. Naturh. Foren. København, 1909, p. 153 (off the Goto Island, 36 and 100 fathoms; description of specimens); Crinoids of the Indian Ocean, 1912, p. 106 (synonymy; habitat); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 178 (range in eastern Asia), p. 181 (22°12′ N., 114°15′E., 14 fathoms; description of specimens); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (southern Japanese species; range and its significance); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 63 (in key; range).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 74, 77 (syzygies), fig. 67, p. 75 (syzygial face), fig. 97, p. 87 (synarthrial face); Vid. Medd. Dansk Naturh. Foren., vol. 83, 1927, p. 2 (stations 2, 10; 0 [?]–135 m.), p. 21 (Mortensen's stations 2, 10; notes), p. 68 (listed), figs. 9, 10, p. 15; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 21.

Diagnostic features.—The arms are 11–14 in number, the IIBr series being 4 (3+4), and are 100–180 mm. long; the cirri are short and stout, strongly and evenly recurved, with 15–20 segments, few or none of which are longer than broad.

So far as is known the color in life is always bright yellow broadly and regularly banded with bright red. Except for the very different *C. magnifica* there is no other comatulid in the area where this occurs that is at all similar in color.

Description.—The centrodorsal is broad, discoidal, with the bare polar area concave. The cirrus sockets are arranged in two closely crowded marginal rows.

The cirri are XXXV–XL, 15–20, stout, about 17 mm. in length. The first segment is about twice as broad as long, the second is about as long as broad, the third-eighth or third-tenth are slightly longer than broad with a strong central constriction and prominent ends, and those following become about as long as broad, the expansion of the ends gradually dying away. The penultimate segment bears a short and small, but prominent, opposing spine, which is subterminal in position but sometimes, owing to the occasionally rather strongly trapezoidal shape of the penultimate segment, appears to be terminal. The opposing spine is directed diagonally outward. The terminal claw is considerably longer than the penultimate segment, moderately stout and moderately curved. Like the opposing spine it is semitransparent and glassy in strong contrast to the dull and brownish cirrus segments. The cirri are laterally compressed in the outer two-thirds.

This disk is lacking. Large and closely crowded sacculi are found on the pinnules.

The radials are very short in the midradial line but are visible as low triangles in the interradial angles of the calyx. The IBr_1 are very short, oblong, strongly rounded dorsally, and well separated laterally. The IBr_2 are broadly triangular, two and one-half or three times as broad as long, and about three times as long as the IBr_1. The IIBr series are 4(3+4), in the type specimen only present on one ray.

The 11 arms (in the type specimen) are 180 mm. in length, very long and slender. The first 9 or 10 brachials are oblong or slightly wedge-shaped, over twice as broad as long, those following becoming triangular, not quite so long as broad, in the outer portion of the arm wedge-shaped and about as long as broad, and in the terminal portion elongated. All the brachials are evenly rounded dorsally with projecting distal edges which are armed with fine spines.

Syzygies occur between brachials 3+4, again between brachials 9+10 (more rarely 10+11), and distally at intervals of 4–8 muscular articulations, the former being the usual number in the distal portion of the arms. In the two arms arising from the single IIBr series there are in both syzygies between brachials 3+4 and 15+16, at which point one of the arms is broken off. In the other the following syzygies are distributed first at intervals of from 5 to 8 muscular articulations, soon becoming pretty uniformly 4 as in the arms arising from the IBr axillaries.

P_D is similar to P_1, 8 mm. long, slender and flagellate, composed of about 30 segments all of which are about as long as broad with the corners cut away; the second-fourth are furnished with thin rounded dorsal keels. The whole pinnule has an appearance recalling that of the oral pinnules in *Heliometra.* P_2 is 11–15 mm. long, flagellate, considerably stouter than P_1 but resembling it in general proportions; it is composed of 35–40 segments, which are about as long as broad, the first two or three with thin rounded dorsal keels. P_3 and P_4 are similar, stouter than P_2, 12–16 mm. in length, composed of short segments like the preceding pinnules, but with the carination of the basal segments less marked. The succeeding pinnules gradually become shorter and less stout, reaching a minimum about the tenth or twelfth, after which they become still more slender and slowly increase in length. The distal pinnules are 12 mm. long, with about 35 segments, of which the first is trapezoidal and not so long as broad, the second is similar but rather longer, and the remainder are about twice as long as broad or rather longer with somewhat abruptly expanded articulations. The segments of all but the distal pinnules have prominent distal ends which are fringed with fine spines.

The color in alcohol is uniform yellowish brown.

Notes.—In the specimen from Mortensen's station 2 as described by Gislén the centrodorsal is discoidal, 5.2 mm. in diameter, with the bare dorsal pole 4.8 mm. in diameter. The cirri are XXXVI, 15–19, from 11 to 16 mm. long. In the longest cirrus segments the ventral length is about equal to the width. The opposing spine is indistinct. The 14 arms are 125 mm. long. The IIBr series are 4(3+4). The IBr_1 are partly visible. There is a synarthrial tubercle on the articulation between the two outer elements of the IIBr series, and another on the articulation between the first two brachials. The distal intersyzygial interval is five or six muscular articulations. P_1 is 9.5 mm. long, with 32 segments. P_2 is 7 mm. long, with 28 segments. P_3 is 7 mm. long, with 23 segments. The distal pinnules are 8.5 mm. long, with about 22 segments. P_d is 10 mm long, with 25 segments; and P_e is 11 mm. long, with 27 segments. The basal segments of the proximal pinnules have inconspicuous flanges. Gislén said that this specimen differs from the type as described only in the slightly shorter P_3, which has fewer segments.

In one of the specimens from Mortensen's station 10 the centrodorsal is 6 mm. in diameter. The cirri are XXXVIII, 15–19, from 9 to 15 mm. in length. The 11 arms are about 100 mm. long. The single IIBr series, which is developed on the right side of a ray, is 4(3+4). P_1 is 6 mm. long, with 25 segments. P_2 is 8.5 mm.

long, with about 30 segments. P_4 is 10 mm. long, with 29 segments. The first six pinnules have a sharp keel on the first-fourth or -fifth segments, this feature becoming less pronounced on the more distal pinnules. P_8 is 5.3 mm. long with about 18 segments. There are three or four sacculi to each pinnule segment.

In the second specimen from Mortensen's station 10 the centrodorsal is 3.8 mm. in diameter, with the bare dorsal pole 2 mm. in diameter. The cirri are XXIV, 16–19, from 9 to 16 mm. long. The radials are 10 times as broad as long, and the IBr_1 are eight times as broad as long. The 10 arms are all broken. Slight synarthrial tubercles are present.

The specimen from off the Goto Islands in 80 meters has 11 arms about 40 mm. long. The single IIBr series is 2.

Of the two specimens from off the Goto Islands in 66 meters, one is just passing from the 10-armed young stage to the adult condition. There are 13 arms 75 mm. long, three IIBr 4(3+4) series being present. Of the three IIBr series, two are of nearly full size while the third is very small, showing that adolescent autotomy had taken place not long before capture. In this specimen there is the same overlapping of the brachials and roughness of the dorsal surface of the arms as in the type, and the relative proportions of the proximal pinnules and of their component segments is similar, though the segments of the pinnules in the proximal third of the arm have rather more prominent distal ends and the lower segments of the first three or four pinnules are rather more strongly carinate. The cirri are XIX, and measure 13 mm. in length. As in the type they are arranged in one and a partial second crowded and irregular marginal row on the discoidal centrodorsal. The cirri show the characteristic somewhat abrupt expansion at the articulations, and consequently the same knobby appearance, as the cirri of the type, but the component segments are slightly shorter, none of them being quite so long as broad. The opposing spine, well marked as in the type, is characteristically small.

The other specimen is small with 12 arms about 45 mm. long. The cirri are XX, and measure 12 mm. in length. They are arranged in a single marginal row on the centrodorsal. The centrodorsal is thin and discoidal, the slightly concave broad bare polar area 4 mm. in diameter.

The best of the five specimens from 8 miles off Hongkong has 13 arms 100 mm. long, the 3 IIBr series being 4 (3+4). The cirri are XXVII, 16–17, about 15 mm. long; the longest proximal cirrus segments are nearly or quite as long as the median width as viewed laterally. A second specimen has 12 arms about 110 mm. long, the 2 IIBr series being 4 (3+4). The cirri are XXVIII, 15, about 13 mm. long. A third example also has 12 arms with the two IIBr series 4 (3+4). There are 14–16 cirrus segments. A small specimen has 10 arms 60 mm. long. The fifth specimen is much broken. The color in life appears to have been bright yellow broadly banded with bright red, as in the type. These specimens agree with the type and with other from southern Japan with which they were compared.

Localities.—Dr. Th. Mortensen's Expedition to Japan station 2; Misaki, shore (but probably taken in dredging); April, 1914 [Gislén, 1927].

Dr. Th. Mortensen's Expedition to Japan station 10; off Kiu Shiu (lat. 33°41′ N., long. 128°50′ E.); 137 meters; sand; May 17, 1914 [Gislén, 1927].

Albatross station 4875; in the eastern channel of the Korean Straits, in the vicinity of the Oki Islands; Oki Shima bearing S. 24° W., 4 miles distant (lat. 34°19′ N., long. 130°09′ E.); 108 meters; fine gray sand and broken shells; August 2, 1906 (fragments, U. S. N. M., 36283).

Albatross station 4880; in the eastern channel of the Korean Straits, in the vicinity of the Oki Islands; Oki Shima bearing S. 79° W., 7.5 miles distant (lat. 34°16′ 00″ N., long. 130°16′ E.); 108 meters; fine gray sand and broken shells; August 2, 1906 [A. H. Clark, 1907, 1908, 1909, 1912, 1913, 1915, 1918; Gislén, 1924] (1, U.S.N.M., 22639).

Korean Straits, off the Goto Islands (lat. 33°10′ N., long. 129°18′ E.); 80 meters; Schønau, November 15, 1895 (1, C. M.).

Korean Straits, off the Goto Islands (lat. 33°09′ N., long. 129°18′ E.); 183 meters; Schønau, May 23, 1898 [A. H. Clark, 1909, 1912, 1913, 1915, 1918; Gislén, 1924] (1, C. M.).

Korean Straits, off the Goto Islands (lat. 33°08′ N., long. 129°20′ E.); 66 meters; Schønau, March 14, 1891 [A. H. Clark, 1909, 1912, 1913, 1915, 1918; Gislén, 1924] (2, C. M.).

Korean Straits, off the Goto Islands (lat. 32°48′ N., long. 129°37′ E.); 73 meters; bottom temperature 11.67° C.; Capt. H. Christiansen, cable repair ship *Nordiske*, April 23, 1912 (2, C. M.).

Northeast of Swatow, China (lat. 23°15′ N., long. 117°40′ E.); Capt. H. Christiansen, July 26, 1912 (2, C. M.).

Eight miles outside of Hongkong Harbor (lat. 22°12′ N., long. 114°15′ E.); 25 meters; Captain Suensson, November 16, 1911 [A. H. Clark, 1913, 1915, 1918; Gislén, 1924] (5, U. S. N. M., E. 1071; C. M.).

Geographical range.—From Sagami Bay to the Korean Straits and southward to Hongkong.

Bathymetrical range.—From 25 to 183 meters; the average of eight records is 98 meters.

Thermal range.—One record, 11.67° C.

History.—This species was first described in 1907 from a single specimen dredged by the *Albatross* in the Korean Straits in 1906.

In 1909 the present author recorded three specimens from two localities in the Korean Straits, where they had been dredged by Danish cable repair ships under the command of Captain Suensson, and in 1913 he recorded five more from near Hongkong, received from the same source.

In 1927 Dr. Torsten Gislén recorded and gave notes upon three specimens which had been collected by Dr. Th. Mortensen in southern and southwestern Japan.

CATOPTOMETRA OPHIURA A. H. Clark

PLATE 9, FIGURES 29, 32

Catoptometra ophiura A. H. CLARK, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 539 (description; *Albatross* stations 5356 and 5414; comparison with *C. hartlaubi*); Crinoids of the Indian Ocean, 1912, p. 106 (synonymy; habitat).—F. W. CLARKE and WHEELER, U. S. Geol. Surv. Prof. Pap. 90–D, 1914, pp. 33 ff. (inorganic constituents of skeleton).—A. H. CLARK. Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed).—F. W. CLARKE and WHEELER, U. S. Geol. Surv. Prof. Pap. 102, 1917, pp. 20 ff. (*Albatross* station 5036; inorganic constituents of the skeleton).—A. H. CLARK, Unstalked crinoids of the *Siboga* Exped., 1918, p. 63 (in key; range), p. 64 (synonymy; notes; stations 49*a*, 294), pp. 271, 275 (listed).—F. W. CLARKE and WHEELER, U. S. Geol. Surv. Prof. Pap. 124, 1922, p. 17 (inorganic constituents of the skeleton).—GISLÉN Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 21, 27.

Diagnostic features.—The arms are 20–27 in number, the IIBr series being 4(3+4), 180 mm. long in fully grown individuals, and the cirri are composed of 15–19 (usually 17–19) segments of which the longest are twice as long as the median width and the outermost are half again as long as broad. In its general appearance this species most nearly resembles *C. rubroflava*, but the greater number of arms and the longer cirri, which are composed of longer segments, easily distinguish it from that form. In color it appears to be usually olive-green or brown, but occasionally red and yellow like *C. rubroflava*.

Description.—The centrodorsal is thin discoidal with a broad moderately concave polar area 5–8 mm. in diameter marked in the center by a shallow rounded pit. The cirrus sockets are arranged in two closely crowded irregular marginal rows.

The cirri are XXVII, 15–18 (usually 17), 22 mm. long. The first segment is about twice as broad as long, the second is not quite so long as broad, the third is half again as long as the median width, the fourth and fifth are twice as long as the median width, and those following gradually become very slightly shorter so that the terminal segments are half again as long as broad. The dorsal and ventral profiles of the longer proximal segments, especially the former, are rather strongly concave, this feature gradually dying away distally. The lateral profiles of these longer proximal segments are very strongly concave, this character gradually becoming less marked but persisting to the end of the cirri. The penultimate segment is about one-third again as long as broad. The opposing spine is terminal, small and inconspicuous. The terminal claw is half again as long as the penultimate segment, slender and slightly curved.

The radials are only just visible in the interradial angles of the calyx. The IBr_1 are oblong, very short and bandlike. The IBr_2 (axillaries) are triangular, nearly three times as broad as long. The IBr series are well separated laterally. The IIBr series are 4(3+4). The $IIBr_1$ are interiorly united for the proximal half or two-thirds, their interior sides diverging from that point so as to make a right angle with each other. The IIIBr series, when present, are 2, always developed interiorly in 1, 2, 2, 1 order. The synarthrial tubercles are prominent and sharp.

The arms are 20–27 in number, 180 mm. in length. The first brachials are wedge-shaped, about twice as broad as long exteriorly, interiorly united for about the proximal two-thirds. The second brachials are of about the same size but more obliquely wedge-shaped. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly, about twice as broad as the median length. The next five brachials are oblong or slightly wedge-shaped, two to three times as broad as long, and those following become triangular and as long as broad, distally obliquely wedge-shaped, and terminally longer than broad. The distal borders of the tenth and following brachials are moderately overlapping and finely spinous.

Syzygies occur between brachials 3+4, again from between brachials 19+20 to between brachials 36+37 (usually about brachials 27+28), and distally at intervals of 8–16 (usually 10 or 11) muscular articulations.

P_D is small and slender, 6 mm. long, with 25–30 segments, most of which are about as long as broad; the second-fifth bear strong dorsal projections. P_1 is 7–8 mm. long, slender, the second-fourth segments with dorsal projections which are not so large as those on the basal segments of P_D. P_2 resembles P_1 but is 15 mm. long, with 40–42 segments, which are about as long as broad, the first-fourth with slight dorsal projections. P_3 is similar to P_2, 12 mm. long. P_4 is similar to P_3, 11 mm. long. P_5 is similar to P_4, 11 mm. long. The following pinnules gradually decrease in length to 7 mm., then slowly increase to 10 mm. distally. The carination of the proximal segments of the lower pinnules becomes progressively less and less, disappearing entirely after the tenth or twelfth.

Notes.—One of the specimens from *Siboga* station 49*a* has the centrodorsal broad and flat, discoidal, with the dorsal pole 6.5 mm. in diameter, marked with faint radiating lines and pitted in the center. The cirri are XXX, 17–19, 23 or 24 mm. long. The cirri, and in fact the whole animal, are less robust than is the case in the specimens in the type series. The other specimen from *Siboga* station 49*a* is slightly smaller, though exactly similar. The dorsal pole of the centrodorsal is 6 mm. in diameter. The cirri are XXVII, 17, 20 mm. long. In these specimens the arm bases, centrodorsal and cirri are light flesh color, the latter becoming pinkish distally; the arms beyond the second syzygy are bright yellow orange regularly banded with bright red as in *C. rubroflava* and in *C. magnifica*.

The specimen from *Siboga* station 294 has 13 arms. The dorsal pole of the centrodorsal is 3 mm. in diameter. The cirri are XX, 16, from 20 to 22 mm. long. The three IIBr series are 4(3+4). This example resembles the two preceding, but the centrodorsal is only half as broad, consequently the cirri appear shorter and more of the division series is visible.

The four specimens recorded in 1911 from *Albatross* station 5356 had 20, 26 (2), and 27 arms.

The specimen from *Albatross* station 5414 is small, with 11 arms about 90 mm. long.

Localities.—*Siboga* station 49*a;* Sapeh Strait, between Sumbava and Komodo (lat. 8°23′30″ S., long. 119°04′36″ E.); 69 meters; coral and shells; April 14, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Siboga station 294; off southwestern Timor (lat. 10°12′12″ S., long. 124°27′18″ E.); 73 meters; soft mud with very fine sand; January 23, 1900 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Albatross station 5356; North Balabac Strait; Balabac light bearing S. 64° W., 15.5 miles distant (lat. 8°06′40″ N., long. 117°18′45″ E.); 106 meters; sand and shells; January 5, 1909 [A. H. Clark, 1911, 1912, 1918; F. W. Clarke and Wheeler, 1914, 1917] (5+, U. S. N. M., 27490, 35131, 35168, 35171, 35175, 35239).

Albatross station 5414; between Cebu and Bohol; Lauis Point light bearing N. 67° W., 9.5 miles distant (lat. 10°10′40″ N., 124°02′45″ E.); 77 meters; coral and sand; March 24, 1909 [A. H. Clark, 1911, 1912, 1918] (1, U. S. N. M., 35170).

Geographical range.—From the Lesser Sunda to the Philippine Islands.

Bathymetrical range.—From 69 to 106 meters; the average of four records is 81 meters.

History.—This species was first described in 1911 from five specimens collected by the *Albatross* in the Philippines in 1909, four of them at station 5356 and a small individual at station 5414.

In 1918 three additional specimens were recorded by the author from two *Siboga* stations.

CATOPTOMETRA HARTLAUBI (A. H. Clark)

PLATE 8, FIGURE 28; PLATE 9, FIGURE 34; PLATE 11, FIGURES 43, 44

[See also vol. 1, pt. 1, fig. 251 (centrodorsal), p. 253; fig. 334 (cirrus), p. 283; fig. 467 (centrodorsal), p. 359; pt. 2, figs. 32, 33 (radial pentagon), p. 20.]

Antedon hartlaubi A. H. CLARK, Proc. U. S. Nat. Mus., vol. 33, 1907, p. 72 (description; *Albatross* station 4934); vol. 34, 1908, p. 475 (listed).

Zygometra koehleri A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 339 (description; *Albatross* station 3717), p. 348 (listed); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 271 (relation to species of *Eudiocrinus*), p. 542 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 63, footnote (synonym of *C. hartlaubi*).

Zygometra hartlaubi A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 348 (listed); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 271 (relation to species of *Eudiocrinus*), p. 276, figs. 6, 7 (centrodorsal and radial articular faces).

Catoptometra hartlaubi A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 317 (listed); vol. 39, 1911, p. 540 (compared with *C. ophiura*); Crinoids of the Indian Ocean, 1912, p. 21 (attains greatest depth of any species of the family), p. 106 (synonymy; habitat); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (southern Japanese species; range and its significance); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 63 (in key; range).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 4 (245 m.), p. 6 (Kiu Shiu and Goto Islands), p. 64 (Bock's station 5; detailed notes), p. 180 (listed), figs. 48–51, p. 70.—GISLÉN, Vid. Medd. Dansk Naturh. Foren., vol. 83, 1927, p. 2 (Mortensen's station 5; 243 m.), p. 20 (station 5; notes), p. 22 (compared with *C. rubroflava*), p. 68 (listed); Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 21, 29.

Antedon hartlanbi S. and R. M. PACE, Zool. Rec., 1907, V. Echinoderma, Dec. 1908, p. 38 Ech.

Catoptometra koehleri A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 317 (listed); Crinoids of the Indian Ocean, 1912, p. 107 (habitat).

Diagnostic features.—The arms are 20–23 (usually 20) in number and 70 to 120 mm. in length; the IIBr series are 4(3+4); the cirri are composed of 14–17 (usually 14–15) segments of which the fourth and following are all about twice as long as broad.

This species is easily distinguished from *C. rubroflava*, which occurs in the same region, by the greater number of arms and by the longer and more slender cirri, which are recurved only in the distal half and are composed of much longer segments. From *C. ophiura* it is distinguished by the more slender and less regularly recurved cirri, which have longer distal segments, by the prominently everted spinous distal ends of the elements of the division series and first two brachials, and by the papillose or finely spinous dorsal pole of the centrodorsal.

Description.—The centrodorsal is a thick disk, with the large bare polar area flat or very slightly concave and beset with well separated small spines. The cirrus sockets are arranged in 2 crowded rows of about 15 each.

The cirri are XXX, 15, 19 mm. long. The first segment is twice as broad as long, the second is somewhat longer, the third is rather longer than broad, and the fourth and following are all approximately twice as long as broad. The ends of the segments in the proximal half of the cirri are slightly enlarged, this feature gradually dying away distally. The opposing spine is represented by a minute tubercle, which may be obsolete. The terminal claw is as long as the penultimate segment, or rather less, and is moderately stout and moderately curved; it is semitransparent and glassy, in contrast to the cirrus segments which are dull and opaque.

The disk is lacking. The sacculi on the pinnules are small but numerous.

The radials are concealed by the centrodorsal. The IBr_1 are also concealed by the centrodorsal. The IBr_2 (axillaries) are very broadly triangular. The IIBr series are 4 (3+4), with the distal ends of the component segments everted and finely serrate.

The 20 arms are 120 mm. in length. The first 9 or 10 brachials are oblong or slightly wedge-shaped, rather more than twice as broad as long, those following becoming triangular, nearly as long as broad, in the distal portion of the arm wedge-shaped again, and in the terminal portion elongate. All the brachials have slightly overlapping and finely spinous distal ends.

Syzygies occur between brachials 3+4, again about brachials 16+17, and distally at intervals of five to eight muscular articulations.

P_D is 4 mm. long, small, weak, and slender, becoming very slender and flagellate in the distal half. It is composed of about 20 segments of which the first four or five are broader than long and the remainder are about as long as broad; the second-fourth or -fifth have rounded triangular dorsal keels, which in shape almost suggest overlapping spines. The basal segments have prominent and finely spinous distal ends, and the dorsal carinate processes are covered with fine spines. P_1 is longer and stouter than P_D, though not quite so long as P_2. P_3 is the longest pinnule, exactly like P_1 and P_2 but slightly stouter basally, 12 mm. long, with about 40 segments, of which the basal five or six are short and the remainder are about twice as long as broad. The second and third segments in P_1, P_2, and P_3 have an indicated dorsal process similar to that on the basal segments of P_1. The following pinnules gradually decrease in length to about 7 mm. though remaining similar to the lower pinnules except that the tip is not so slender, then gradually increase in length distally. The distal pinnules are 11 mm. long with the first segment short and approximately oblong, about twice as broad as long, the second about as long as broad, and those following becoming very rapidly elongated and very long and exceedingly slender distally. The elongated segments have somewhat abruptly expanded articulations, and all the segments, especially the lower, have the ends more or less spinous and often scattered spines on the dorsal surface.

Notes.—The eight specimens from off the Goto Islands are all much broken. The centrodorsal is discoidal, moderately thick, that of the largest being 6.2 mm. in basal diameter. The dorsal pole is flat or very slightly concave, in the largest being 4 mm. in diameter. The cirrus sockets are arranged in one and a more or less complete second irregular closely crowded marginal rows. Interradially the centrodorsals are 1.5–2 mm. high. The lateral borders slope inward only very slightly. The longest cirri are 19 mm. long with 16 segments, which are subequal, one-third again to twice as long as broad. All the specimens appear to have had 20, or about 20, arms. Those of the largest are about 140 mm. long. As in the type specimen, the distal edges of the ossicles of the division series are everted and spinous. A small specimen has 10 arms between 55 and 60 mm. long and the cirri 8 mm. long with 10–12 segments.

The specimen from Bock's station 5 was thus described by Gislén: The centrodorsal is large, flattened, slightly concave in the center, with calcareous granules which toward the margin are arranged in about 10 rays. It is 5 mm. in diameter and 0.8 mm. high, with the bare dorsal pole 3.5 mm. in diameter. The cirri are XXVIII, 14–17, from 11 to 17 mm. long. The shorter dorsal cirri have 14 or 15 and the longer ventral have 16 or 17 segments. The cirri are arranged in two closely crowded alternating rows. The second segment is about as long as broad, and the third is a little longer and is slightly constricted centrally, as are most of the segments following. The fifth-seventh segments are twice as long as broad, and those succeeding are from one-half to one-quarter again as long as broad, and are without dorsal spines. The penultimate segment is one-fifth again as long as broad with a median very weak opposing spine the height of which is equal to about one-fifth the width of the segment. The terminal claw is slender, somewhat curved, and is longer than the penultimate segment. The radials and the IBr_1 are concealed by the centrodorsal except for the distal edge of the latter. The IBr_1 are united laterally. The IBr_2 (axillaries) are triangular, four times as broad as long. The IIBr series are 4(3+4). The $IIBr_1$ are twice as long exteriorly as interiorly and are united interiorly. There is a synarthrial tubercle on the articulation between the first two elements of the IIBr series, and another inconspicuous one on the articulation between the first two brachials. The 20 arms (or perhaps 19, as one of the IIBr series is broken off at the syzygy between the two outer elements) are 70 mm. long. The first-eighth brachials are discoidal. The proximal brachials are short, and the outer are about as long as broad. All the distal brachials are somewhat compressed in the middle, with the distal ends everted and armed with small spines. There are 17 brachials in each 10 mm., or 15 if the syzygial pairs are counted as units. On a typical arm syzygies occur between brachials 3+4, 11+12, 21+22, 30+31, and distally at intervals of about seven muscular articulations. The pinnule on the IIBr series is 7 mm. long with 29 segments, of which the first seven are stout and those following more slender. P_1 is 13 mm. long with 33 segments, which are a little longer than broad, the second-fourth with small prominences resembling those on the proximal pinnules of, for instance, *Comatula pectinata*, but very much less developed. P_2 is of about the same length. P_3 is about 10 mm. long. P_a is 5.5 mm. long, with about 20 segments. The genital pinnules are 12 mm. long. The distal pinnules are 8 mm. long, with 20 segments. The basal pinnule segments, especially on the proximal pinnules, have small spiny prominences. There are three pairs of small sacculi to each pinnule segment. The disk is lacking. The color in formalin is white. Dr. Gislén remarked that this specimen comes closest to *Catoptometra hartlaubi* from which it differs in the occurrence of an opposing spine and in the pinnules which, compared with the arm length, are somewhat longer.

In the specimen from Mortensen's station 5, as described by Gislén, the cirri are XXXII, 14–16, from 11 to 15 mm. long. The penultimate segment bears an indistinct opposing spine. The 23 arms are 80+ mm. long. Of the 10 IIBr series eight are 4(3+4) and two are 2(1+2). Of the five IIIBr series three are 4(3+4) and two are 3, both of the last on a IIBr 2 series. With 10 IIBr and five IIIBr series present the number of arms must be 25 instead of 23, as given by Gislén. The distal border of the brachials is rather strongly everted and serrate. The distal intersyzygial interval is five or six, or eight, muscular articulations. The pinnule on the IIBr series is

6.5 mm. long, with about 23 segments. P_1 is 9.5 mm. long, with about 30 segments. Some of the proximal cirrus segments, except the first, have an insignificant flange. The disk is detached. It is 9 mm. in diameter. The mouth is central, slitlike, extending from the anterior interradius toward the posterior radius. The perisome is naked except for insignificant granules along the ambulacral furrows.

The specimen from *Albatross* station 3717 originally described under the name of *Zygometra koehleri* presents the following characters: The centrodorsal is a flat disk. The marginal cirri are about XX, 10–15, short and rather stout. The first two segments are short, and those following are longer than broad and somewhat constricted centrally. The opposing spine is very small, and the terminal claw is short and curved. The radials are just visible beyond the edge of the centrodorsal, and are free distally. The IBr_1 are nearly three times as broad as long and are united to the low triangular IBr_2 (axillaries) by syzygy. The IBr series are dorsally rounded and are widely free laterally. The 10 arms are 45 mm. long and are composed of 65–80 brachials, of which the first seven are oblong or slightly wedge-shaped, broader than long, those following are wedge-shaped and as long as or longer than broad, and the distal become elongate. Syzygies occur between brachials 3+4, 9+10 and 14+15, and distally at intervals of four or five muscular articulations. P_1 is long and slender, with more than 20 segments, of which the basal three or four are broader than long and the remainder are elongate. P_a is distinctly, and often much, shorter, with fewer segments. P_2 is the longest, with about 25 elongated segments. The following pinnules are not much shorter but are very much more slender. The anal tube and the posterior interradius are heavily plated, but the rest of the disk is almost naked. The color in life was bright yellow.

Localities.—Korean Straits, off the Goto Islands (lat. 32°20′ N., long. 128°15′ E.); 201 meters; bottom temperature 11.67° C.; Captain Suensson, May 17, 1911 (8, U.S.N.M., E. 1088; C.M.).

Albatross station 4933; Eastern Sea, off Kagoshima Gulf; Sata Misaki light bearing N. 84° E., 8.5 miles distant (lat. 30°59′00″ N., long. 130°29′50″ E.); 278 meters; rocky bottom; August 16, 1906 (1, U.S.N.M., 35169, 36232).

Albatross station 4934; Eastern Sea, off Kagoshima Gulf; Sata Misaki light bearing N. 77.5° E., 7 miles distant (lat. 30°58′30″ N., long. 130°32′00″ E.); 188–278 meters; rocky bottom; August 16, 1906 [A. H. Clark, 1907, 1912, 1918] (1, U.S.N.M., 22606).

Dr. Sixten Bock's Expedition to Japan station 5; off Kagoshima; 247 meters; May 13, 1914 [Gislén, 1922].

Dr. Th. Mortensen's Expedition to Japan station 5; off Kiu Shiu, 9 miles W. to N., ½ N., of Bonomisaki; 247 meters; sand and shells; May 13, 1914; presumably identical with the locality just preceding [Gislén, 1927].

Albatross station 3704; Sagami Bay; Ose Zaki bearing S. 53° W., 2.25 miles distant; 115–137 meters; volcanic sand and gravel; May 8, 1900 (1, U.S.N.M., 35134).

Albatross station 3717; Sagami Bay; Ose Zaki bearing S. 34° E., 0.8 mile distant; 137–183 meters; volcanic sand, shells and rock; May 11, 1900 [A. H. Clark, 1907, 1912, 1918] (1, U.S.N.M., 22660).

Geographical range.—Southern Japan, from the Korean Straits to Sagami Bay.

Bathymetrical range.—From 137 (?115) to 278 meters; the average of six records is 196 meters.

Thermal range.—One record, 11.67° C.

History.—This species was described originally under the name of *Antedon hartlaubi* in 1907 from a specimen dredged by the *Albatross* in the Korean Straits in 1906. Later in the same year another young individual from *Albatross* station 3717 in Sagami Bay was described as *Zygometra koehleri.* In 1918 in the report upon the *Siboga* collection *koehleri* was placed in the synonymy of *hartlaubi.*

In 1922 Dr. Torsten Gislén described in detail a specimen which had been collected by Dr. Sixten Bock off Kagoshima, and in 1927 he described another from Dr. Th. Mortensen's collection, which apparently was taken at the same time and place.

Family EUDIOCRINIDAE A. H. Clark

Eudiocrinidae A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 344 (in part; new family to include *Eudiocrinus* and *Decametrocrinus*); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (name replaced by Pentametrocrinidae, the genus *Eudiocrinus* being transferred to the Zygometridae); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 210 (in part; in key; includes *Eudiocrinus* and *Decametrocrinus*; range), p. 211 (represented in Hawaiian Islands), p. 212 (range of component genera); Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 554 (including *Eudiocrinus* only); Temminckia, vol. 1, 1936, p. 300; John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, pp. 99, 103.

Zygometridae (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (includes *Zygometra* and *Eudiocrinus*). [For subsequent references see page 76.]

Diagnosis.—A family of the superfamily Mariametrida in which the elements of the IBr series are united by syzygy and the IBr_2 is not axillary, but bears a pinnule, the arms being therefore only five in number. The perisome of the disk is completely covered by a pavement of irregular plates (see Part 2, p. 226, fourth paragraph), and the lateral perisome of the pinnules contains an inner and an outer row of spicules (see Part 2, p. 238, and figs. 787 and 788, p. 366).

Geographical range.—From the Maldive Islands, Cape Negrais, Burma, and the Andaman Islands to the Lesser Sunda and Kei Islands, the Moluccas, the Philippine and Bonin Islands, and southern Japan.

Bathymetrical range.—From 36 to 183 meters.

Remarks.—The possession of only five arms easily distinguishes the species of the family Eudiocrinidae from all other comatulids except the species of *Pentametrocrinus* in the family Pentametrocrinidae and the species of *Atopocrinus* in the family Atelecrinidae of the suborder Macrophreata (see Part 5).

In the Eudiocrinidae the first two postradial ossicles are the equivalent of the IBr series in comatulids with 10 or more arms, but the IBr_2 is not axillary, simply bearing a pinnule. The third postradial ossicle is the equivalent of the first brachial of the free undivided arms in other comatulids, and consequently does not bear a pinnule. In the Pentametrocrinidae the IBr series are absent, the first ossicle following the radials representing the first brachial of the free undivided arms in other comatulids.

It is interesting that in the Eudiocrinidae the sequence of the pinnules is that seen on the free undivided arms in other comatulids—that is, P_C and P_1 are similar, forming the first pair; P_a and P_2 are similar, forming the second pair; and so on—whereas it might be expected that the pinnule of the IBr series (P_C) would be an odd pinnule and that the grouping of the pinnules in pairs would commence with P_1 as is the case in other comatulids with pinnules on the division series.

In the occurrence of a syzygy between the elements of the IBr series and in the plating of the disk the Eudiocrinidae agree with the Zygometridae. These two families also agree in the structure of the articular faces of the radials, the agreement between *Eudiocrinus* (see Part 2, p. 22, figs. 29, 30, p. 20) and *Catoptometra* (see Part 2, p. 21, figs. 32, 33, p. 20) being especially close. In those species of Zygometridae in which adambulacral deposits are found in the lateral perisome of the pinnules these deposits are of the type characteristic of the Eudiocrinidae, although they are more or less reduced.

In the Eudiocrinidae the disk is more heavily plated than it is in the Zygometridae, the adambulacral rods are always large, and there are large filmy plates over the gonads. It may be remarked that in the genus *Mariametra* of the family Mariametridae the disk is always well plated, although there are no other features to suggest affinity with the Zygometridae or Eudiocrinidae.

The Zygometridae and the Eudiocrinidae, though quite distinct, possess in common a number of features that clearly indicate a rather close relationship and at the same time set them off rather sharply from the 3 other families in the Mariametrida—the Himerometridae, Mariametridae, and Colobometridae—which similarly are closely allied.

History.—The family name Eudiocrinidae was first proposed by me in 1907 to include the genera *Eudiocrinus* and *Decametrocrinus*. The genus *Eudiocrinus* was accepted in the sense in which it was used by Carpenter—that is, as including the species now assigned to it and also the species now referred to *Pentametrocrinus*. At that time I had at hand many specimens of Carpenter's *Eudiocrinus* (*Pentametrocrinus*) *varians* and *E.* (*P.*) *japonicus*, which I had collected in southern Japan in the previous year, but I had never seen a specimen of *Eudiocrinus indivisus* or of any closely related species. My concept of the genus *Eudiocrinus* was therefore based entirely on species of *Pentametrocrinus*, and the family Eudiocrinidae as proposed was in intent the equivalent of the family Pentametrocrinidae as now understood.

Shortly after the publication of this paper I acquired a specimen of a species related to *Eudiocrinus indivisus*—the type specimen of *E. variegatus*—and a study of this individual showed that the group of species represented by *E. indivisus* is entirely different from the group represented by *E. varians* and *E. japonicus*. In a paper published on April 11, 1908, I established the new genus *Pentametrocrinus* for *E. varians* and its allies and created the new family Pentametrocrinidae for the reception of *Pentametrocrinus* and *Decametrocrinus*. I showed that *Eudiocrinus*, as represented by *E. indivisus*, is characterized by the possession of IBr series of which the IBr_2 is not axillary, which are wholly unrepresented in *E. varians* and its allies (the genus *Pentametrocrinus*), and that it is most closely related to the genus *Zygometra*. I therefore created the new family Zygometridae to include the genera *Zygometra* (which at that time included also *Catoptometra*) and *Eudiocrinus*.

In a paper published later in the same year (May 14), but written before the receipt of the type specimen of *Eudiocrinus variegatus*, the family Eudiocrinidae appears as including *Eudiocrinus* and *Decametrocrinus*, and the family Zygometridae as including *Zygometra* only.

Until the present time the genus *Eudiocrinus* has remained in the family Zygometridae to which it was assigned in 1908.

Genus EUDIOCRINUS P. H. Carpenter

Ophiocrinus (not of Salter, 1856, nor of Angelin, 1878) Semper, Archiv für Naturg., 1868, vol. 1, p. 68 (diagnosis; genotype *O. indivisus*).—P. H. Carpenter, Nature, vol. 15, 1877, p. 198.—Schlüter, Zeitschr. deutsch. geol. Ges., Jahrg. 1878, p. 40.—P. H. Carpenter, Nature, vol. 19, 1879, p. 450; Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 17; Proc. Roy. Soc., No. 194, 1879, p. 385.—de Loriol, Monogr. des crinoides fossiles de la Suisse, 1879, p. 227.—Zittel, Handbuch der Palaeontologie, vol. 1, 1876–1880, p. 346 (referred to the Comatulidae), p. 397 (a recent type).—P. H. Carpenter, Quart. Journ. Geol. Soc., vol. 36, 1880, p. 41; Bull. Mus. Comp. Zool., vol. 9, 1881, p. 161 (p. 11 of separate) (saceuli).—Perrier, Compt. Rend. Acad. Sci., vol. 96, 1883, p. 725.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 271 (history and status).

Comatula (*Ophiocrinus*) de Loriol, Denkschr. allgem. schweiz. Ges. ges. Naturw., vol. 23, 1869, p. 57.

Eudiocrinus P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 493 (new name for *Ophiocrinus* Semper, 1868, preoccupied); Proc. Roy. Soc., vol. 35, 1883, p. 138.—Perrier, Compt. Rend. Acad. Sci., vol. 96, 1883, p. 725; Ann. Mag. Nat. Hist., ser. 5, vol. 11, 1883, p. 294.—P. H. Carpenter, Phil. Trans. Roy. Soc., vol. 174, pt. 3, 1883 (1884), p. 926; *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, pp. 36, 47, 58, 68, 137, 138, 140, 143, 291, 373; Narrative, vol. 1, pt. 1, 1885, p. 310.—Perrier, Explorations sous-marines, 1886, p. 275.—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 73.—de Loriol, Paléontologie française, Terrain jurassique, vol. 11, pt. 2, 1889, p. 434.—Perrier, Traité de zoologie, 1893, p. 784.—Bather, Proc. Zool. Soc. London, 1895, p. 995.—Lang, A text book of comparative anatomy, vol. 2, 1896, p. 313.—Bather, in Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, p. 195.—Delage and Hérouarn, Traité de zoologie concrète, vol. 3, 1903, p. 394.—Minckert, Archiv für Naturg., Jahrg. 71, 1905, vol. 1, p. 166.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 569 (found abundantly off southern Japan by the *Albatross;* refers to *Pentametrocrinus*), p. 573 (list of known species with original references and type localities; all but one [*indivisus*] are species of *Pentametrocrinus*).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575 (listed).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 343 (included by Carpenter in the family Comatulidae), p. 344 (most nearly related to *Decametrocrinus;* here united with it in the family Eudiocrinidae); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (restricted by the removal of 5 species to *Pentametrocrinus*), p. 135 (assigned to the family Zygometridae); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 210 (referred to the Eudiocrinidae), p. 212 (occurs in West Indies and Japan [refers to *Pentametrocrinus*]), p. 269 (arm structure), p. 271 (history; structure; included species distributed among 2 genera, *Eudiocrinus* and *Pentametrocrinus*, the former assigned to the Zygometridae, the latter to the Pentametrocrinidae), p. 276 (revised diagnosis; list of species), pp. 307, 436, 519; vol. 35, 1908, p. 113; fig. 4, p. 118; p. 125 (arm structure); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 2 (cirri and lower pinnules compared with those of Charitometridae); Vid. Medd. Naturh. Foren. København, 1909, p. 152 (cirri and brachials compared with those of *Zygometra fluctuans* [*comata*]), p. 193 (probably occurs at Singapore though not yet discovered there); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); Crinoids of the Indian Ocean, 1912, p. 9 (absent from Australia), p. 11 (occurs in the Andamans), p. 21 (range); p. 56 (in key), p. 99 (synonymy; type).—Reichensperger, Zeitschr. für wiss. Zool., vol. 101, Heft 1–2, 1912, p. 32 (saceuli); A. H. Clark, Die Crinoiden der Antarktis, 1915, p. 121 (belongs to the Zygometridae, though with only 5 arms); Amer. Journ. Sci., vol. 40, 1915, p. 62 (list of recent species), p. 63 (number of recent and fossil species; range), p. 65 (confined to western Pacific); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 32 ff. (phylogenetic study); Unstalked crinoids of the *Siboga*-Exped., 1918, p. VIII (discovery of 3 remarkable species by the *Siboga*); p. 64 (key to the included species); Univ. Iowa Stud. Nat. Hist., vol. 9, No. 5, 1921, p. 14 (includes both recent and fossil species; not known from West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 17.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 68, 73; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 25, 30 (has P_1 [P_C] to the left), p. 35 (brachial homologies), p. 44 (reversion), p. 49, p. 84 (distal intersyzygial interval), pp. 106, 107, 115, 117; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 17.

Endiocrinus Bather, Rept. Brit. Assoc. for 1898, 1899, p. 923.—Chun, Aus den Tiefen des Weltmeeres, 1900, p. 488.—Hutton, Index faunae Novae Zelandiae, 1904, p. 291.

Eudiocrinis A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 12.

Eudiocriuus, Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 182.

Diagnosis.—A genus of comatulids with five arms only; IBr series are present in which the two elements are united by syzygy and the distal bears a pinnule instead of being axillary.

This is the only genus in the family Eudiocrinidae; for further information regarding its characters and relationships see page 143.

Geographical range.—From the Maldive Islands, Cape Negrais, Burma, and the Andaman Islands to the Lesser Sunda and Kei Islands, the Moluccas, the Philippine and Bonin Islands, and southern Japan.

Bathymetrical range.—From 36 to 183 meters.

Remarks.—While the genus *Eudiocrinus* is one of the most clearly delimited and most definitely characterized of all comatulid genera the interrelationships of the included species are as yet by no means entirely clear.

The curious elongated cirri of *E. junceus* seem to be quite distinctive, differentiating that species sharply from all the others. But as it has only been taken once we know nothing of its geographical or other variations.

Similarly the short and strongly recurved cirri composed of short segments characteristic of *E. variegatus*, *E. loveni*, and *E. pinnatus* seem to indicate that these species form a natural group. But these species are very insufficiently known, while the cirri in certain individuals of other species sometimes approach the short-segmented type rather closely.

The small and slender *E. venustulus* appears to be a well-marked form, although it is sometimes rather easily confused with the young of the larger and stouter species.

Though on the basis of our present information *E. gracilis*, *E. pulchellus*, and *E. eoa* appear to be quite distinctive, as yet we know very little about them.

Whether *E. ornatus*, *E. philenor*, and *E. serripinna* are to be regarded as species or as forms of *E. indivisus* is more or less a matter of personal opinion. The interrelationships of *serripinna*, *ornatus*, and *indivisus* are extraordinarily similar to the interrelationships between *Oligometra serripinna* and its corresponding varieties.

History.—In 1868 Prof. Carl Semper established the genus *Ophiocrinus* for the reception of a curious little comatulid that he called *Ophiocrinus indivisus* from the Philippine Islands. In the following year a second species was described by Prof. Percival de Loriol under the name of *Comatula* (*Ophiocrinus*) *hyselyi* from the Neocomian of Switzerland.

The generic value of the character separating *Ophiocrinus* from *Antedon* or *Comatula*, as those genera were understood at that time, was doubted by Schlüter in 1878, and P. H. Carpenter had some hesitation in regarding it as equivalent to *Antedon*, *Actinometra*, and *Promachocrinus*.

The *Challenger* had dredged three species of 5-armed comatulids in the western Pacific, and in 1882 Carpenter described these, at the same time redescribing Semper's *Ophiocrinus indivisus*, the type and only specimen of which had been acquired by his father. Carpenter pointed out that the generic name *Ophiocrinus* had been used by Salter in 1853 and was not therefore available for Semper's genus, for which he proposed the name *Eudiocrinus*. Carpenter noted that "in its central mouth and in the structure of the calyx *Eudiocrinus* is essentially an *Antedon*. But the sacculi which are usually so abundant at the sides of the ambulacra of this genus are not so constant in *Eudiocrinus*. *E. indivisus* has numbers of them, while they are scanty in *E. varians*, and altogether absent in the two remaining species [*semperi* and *japonicus*], which I have never found to be the case in *Antedon*, though I have examined over one hundred species of this genus." He noted that in *E. indivisus* the sacculi are "tolerably close on the arms, but larger and more closely set at the sides of the pinnule-ambulacra, which have only the very slightest trace of any superficial limestone deposits."

In 1884 in his report upon the stalked crinoids collected by the *Challenger*, Carpenter discussed *Eudiocrinus* at considerable length. He remarked that in *E. indivisus* the two ossicles following the radials are united by syzygy, and the epizygal of this syzygial pair bears a pinnule "which clearly shows that they must be considered as arm-joints and not as belonging to the calyx, although they undoubtedly represent the so-called second and third radials [the ossicles of the IBr series] of a ten-armed Crinoid." He said further that in the other species of *Eudiocrinus* — that is, in the species now assigned to *Pentametrocrinus* — these primitively separate ossicles are not united by syzygy but are articulated, just as in *Thaumatocrinus* [= the young of *Decametrocrinus*]. The second one bears a pinnule both in *Thaumatocrinus* and in *Eudiocrinus* [*Pentametrocrinus*] *varians;* but in *Eudiocrinus* [*Pentametrocrinus*] *semperi* and in *E.* [*P.*] *japonicus* the first pinnule is on the fourth ossicle after the radial. He said that this would correspond to the second brachial of a 10-armed crinoid, but it is really the fourth brachial in *Eudiocrinus*. Lastly, he remarked, in Perrier's *Eudiocrinus atlanticus* the first pinnule is on the fifth brachial, which corresponds to the third brachial of an *Antedon*.

In the *Challenger* report on the comatulids published in 1888 Carpenter gave no new information regarding *E. indivisus*. His account of the genus *Eudiocrinus* is based almost wholly upon the three species of *Pentametrocrinus* secured by the *Challenger* and the one (*atlanticus*) described by Perrier. His description of the disk and of the articular faces of the radials is entirely based upon the *Challenger* species of *Pentametrocrinus*.

In 1894 Prof. F. Jeffrey Bell described and figured a second species of *Eudiocrinus* from the Macclesfield Bank, which was closely related to *E. indivisus*. In fact Bell's new species, *E. granulatus*, subsequently proved to be a synonym of *E. indivisus*.

In 1908, having obtained from southern Japan a single specimen of a new species, which I described as *Eudiocrinus variegatus*, I showed that whereas in *E. indivisus* and its close relatives the two ossicles united by syzygy immediately following the radials are the equivalent of the IBr series in comatulids with 10 or more arms (as was suggested by Carpenter in 1884) there are no representatives of the IBr series at all in *Eudiocrinus varians*, *E. japonicus*, *E. semperi*, *E. atlanticus*, or *E. tuberculatus*. These last I therefore removed from the genus *Eudiocrinus*, placing them in the new genus *Pentametrocrinus*. At the same time I showed that *Eudiocrinus*, as restricted by the removal of various species to *Pentametrocrinus*, is most closely related to *Zygometra*, and I united *Eudiocrinus* and *Zygometra* in the new family Zygometridae.

In another paper published in 1908 I described *Eudiocrinus serripinna*, which had been dredged by the *Albatross* at station 5136 in the Philippines, and in 1909 I described *E. ornatus,* which had been dredged by the Royal Indian Marine Surveying steamer *Investigator* at station 61 north of the Andamans. In 1911 I recorded *E. indivisus* from *Albatross* station 5356 in the Philippines.

In 1912, *Eudiocrinus junceus, E. pinnatus,* and *E. venustulus* were described from the collections of the Dutch steamer *Siboga* in the East Indies, and in a monograph on the crinoids of the Indian Ocean *E. ornatus* was redescribed and figured, a new species, *E. minor,* was also described and figured, and another new species, *E. gracilis,* was described. In the same year I described also a second specimen of the Japanese *E. variegatus,* which I had studied at the Hamburg Museum, and in 1913 I published notes upon the type specimen of Bell's *E. granulatus,* which I had examined in the British Museum in 1910.

In a report upon the crinoids collected by the *Siboga* published in 1918, *Eudiocrinus junceus, E. pinnatus,* and *E. venustulus* were redescribed and figured, and *E. ornatus, E. serripinna,* and *E. indivisus* were recorded from various *Siboga* stations.

In 1922 Dr. Torsten Gislén recorded *E. indivisus* from the Bonin Islands, and from the same region described *E. gracilis* var. *pulchellus* and *E. loveni,* the specimens having been secured by Dr. Sixten Bock during his expedition to Japan in 1914.

In 1924 Dr. Gislén published extensive notes on the structure of the genus based upon the material from the Bonin Islands.

KEY TO THE SPECIES IN THE GENUS EUDIOCRINUS

*a*¹. Cirri composed of much elongated segments of which the longest are 3½ to 4 times as long as median width or longer, and the distal are twice as long as broad.

*b*¹. Cirri greatly elongated with 22 elongated segments, tapering from base to tip, 23 mm. long; enlarged proximal pinnules stout basally, very long, tapering gradually to a delicate, almost flagellate, tip; arms 90 mm. long (Moluccas; 95 meters)---------------**junceus** (p. 149)

*b*². Cirri less elongated with 13–15 segments, not tapering distally, 10 mm. long; enlarged proximal pinnules not especially long, tapering evenly to tip; arms 40 mm. long (Mergui Archipelago; 110 meters)---------------**philenor** (p. 151)

*a*². Cirri shorter, with the longest segments never more than 2½ times as long as broad.

*b*¹. Cirri of moderate length, not especially stout, with the earlier segments markedly longer than broad, about twice as long as median width or longer.

*c*¹. First segment of P_C with a very large spatulate or fan-shaped process as high as width of segment, and following segments with high carinate processes, which rapidly diminish in height distally; ossicles of IBr series and earlier brachials with edges swollen and everted and more or less scalloped or beaded; a slender and delicate species (Philippines to Kei and Lesser Sunda Islands; 73–112 meters)---------------**venustulus** (p. 160)

*c*². Slight and uniform, if any, processes on basal segments of proximal pinnules; not markedly slender and delicate.

*d*¹. Cirri very slender, strongly recurved, and composed of 11 or 12 segments of which the longest are about 2½ times as long as median width, and antepenultimate is half again as long as broad (Philippines; about 46 meters)---------------**eoa** (p. 162)

*d*². Cirri not especially slender with shorter segments of which distal are not, or at least are not appreciably, longer than broad.

*e*¹. Ossicles of IBr series and earlier brachials with everted and more or less produced edges, dorsal profile of earlier portion of arms being strongly serrate.

*f*¹. Proximal pinnules very sharply triangular in section; on P_2 and P_a distal edges of segments are very strongly produced at prismatic angles dorsally so that pinnules have a strongly serrate dorsal profile (Philippines to Kei and Lesser Sunda Islands; 40–100 meters)---------------**serripinna** (p. 169)

f^2. P_1 and P_a rounded triangular, distal edges of segments everted and spinous all around dorsal side, this being slightly, if at all, accentuated at prismatic angles (Andaman to Lesser Sunda and Kei Islands; 73–90 meters)________________**ornatus** (p. 172)

e^2. Edges of ossicles of IBr series and earlier brachials only slightly, if at all, everted, so that dorsal profile of earlier portion of arms is smooth.

f^1. Third segment of P_1 and P_a not longer than broad (Bonin and Philippine Islands and the Macclesfield Bank to Moluccas and Kei and Lesser Sunda Islands; 36–183 meters)________________**indivisus** (p. 163)

f^2. Third segment of P_1 and P_a half again as long as broad.

g^1. P_a and P_2 scarcely longer or slenderer than other proximal pinnules; arms up to 40 mm. in length and cirri up to 7 mm. in length (Bonin Islands; ?128–183 meters) **pulchellus** (p. 177)

g^2. P_a and P_2 markedly longer than succeeding pinnules; arms 55 mm. and cirri 9 mm. long (Maldive Islands to Burma and Kei Islands; 73–89 meters)_**gracilis** (p. 175.)

b^2. Cirri stout and strongly curved, none of component segments appreciably longer than broad.

c^1. P_a and P_2, though elongated and stiffened, are slender like the succeeding pinnules and not enlarged; third and fourth segments are half again as long as broad and outer are 3 or 4 times as long as broad.

d^1. P_a and P_2 are one-third or one-fourth again as long as succeeding pinnules and are composed of 16 or 17 segments (Lesser Sunda to Kei and Philippine Islands; 46–85 meters) **pinnatus** (p. 153.)

d^2. P_a and P_2 are not longer than succeeding pinnules and are composed of 11 segments (Bonin Islands; ?146 meters)________________**loveni** (p. 156.)

c^2. P_a and P_2 are enlarged as well as stiffened; they are composed of 11 or 12 segments of which first 4 are broader than long and outer are about twice as long as broad (southern Japan; 110 meters)________________**variegatus** (p. 157)

EUDIOCRINUS JUNCEUS A. H. Clark

PLATE 10, FIGURES 35, 36

[See also vol. 1, pt. 1, fig. 83 (side view), p. 136; pt. 2, fig. 788 (ambulacral deposits), p. 366.]

Eudiocrinus junceus A. H. CLARK, Proc. Biol. Soc. Washington, vol. 25, 1912, p. 25 (description; *Siboga* station 167); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 64 (in key; range), p. 65 (references; detailed description; Sta. 167), fig. 3, p. 66, p. 273 (listed), pl. 17, figs. 31, 32; Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 20 (ambulacral deposits); Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 556 (compared with *E. philenor*).

Diagnostic features.—The long tapering cirri with elongated segments and the greatly enlarged and slowly tapering P_a and P_2 easily distinguish this species from all the others in the genus.

Description.—The centrodorsal is discoidal, moderately thick, the sides converging rather strongly; the flat dorsal pole is 1.0–1.5 mm. in diameter. The cirrus sockets are arranged in two closely crowded and irregular rows.

The cirri are XXV, 22, 23 mm. long, greatly elongated with elongate segments, very slender, tapering from the base to the tip, rather more strongly in the first three or four segments than subsequently. The first segment is short, the second is not so long as broad, the third is nearly or quite twice as long as the proximal diameter, the fourth is about four times as long as the median diameter, and the sixth, seventh, and eighth are very slightly longer. From this point onward the length almost imperceptibly decreases so that the seventeenth and following segments are slightly over twice as long as broad. The penultimate segment is half again as long as broad, tapering somewhat distally. The opposing spine is represented by a small rounded subterminal tubercle. The terminal claw is slightly longer than the penultimate segment, very slender and sharp, and only slightly curved. The second and third segments are rather strongly constricted centrally; the sixth and following have moderately expanded and slightly overlapping distal ends; both of these characters gradually die away distally. From the fifth segment onward the cirri are rather strongly compressed laterally.

The radials are just visible beyond the edge of the centrodorsal; their distal border is swollen and turned outward, smooth or evenly tuberculated. The ossicles of the IBr series (united in a syzygial pair) taken together form an element that is oblong, not quite twice as broad as long; both the proximal and the distal borders are turned outward, the former slightly, but the latter standing up at right angles to the general surface of the segment, with a smooth and somewhat thickened edge; the proximal edge may be more or less scalloped, and bears just within the border a prominent rounded tubercle; the produced distal edge is thickest and most prominent in the middorsal half, this portion being distally evenly concave; the remainder of the distal edge may be broadly scalloped.

The five arms are 90 mm. long. The first brachial is oblong, two and one-half to three times as broad as long, with the proximal and distal edges slightly thickened and everted. The second brachial is similar, but the distal edge is prominently everted, especially in the central third where the eversion is thickened and distally concave, standing up vertically from the dorsal surface of the segment. The first syzygial pair (composed of brachials 3+4, or the fifth and sixth postradial ossicles) is slightly longer on one side than on the other, about twice as broad as the lesser length; this syzygial pair resembles the preceding syzygial pair (composed of the two elements of the IBr series), but the tubercle just within the proximal border is only very slightly indicated. The following three brachials are slightly wedge-shaped, about twice as broad as the median length, with the distal borders everted as described for the second brachial, but progressively less and less so. The following brachials are triangular, about as long as broad, with slightly produced and overlapping distal edges. From the fourth to the ninth brachials there is a low median carination which after the ninth becomes the low rounded zigzag keel characteristic of the arms of all the species of this genus, which is traceable throughout the entire length of the arms.

P_C is 6.5 mm. long, with 15 segments, rather stout basally, but tapering rapidly to a very delicate tip, and strongly prismatic. The first segment is much broader than long, the following gradually increasing in length and becoming about as long as broad on the fourth or fifth, and terminally twice as long as broad. The second-sixth segments have a narrow sharp carination the crest of which is straight and parallel to the longitudinal axis of the pinnule; the outer edge of the prism formed by the pinnule is sharp; the outer surface of the pinnulars between the prismatic angles is flat or very slightly concave. P_1 is similar, 6.5 mm. long, with 13 or 14 segments. P_a is 11 mm. long, with 15 segments, much larger and stouter than those preceding, tapering evenly from the base and becoming very delicate distally. The first segment is much broader than long, the following gradually increasing in length and becoming about as long as broad on the fourth and three times as long as broad terminally. The second, third, and fourth segments have a low even carination. The second and following have the distal edges all around produced and finely spinous. P_2 is 11 mm. long, with 15 segments, exactly resembling P_a. P_b is 8–10 mm. long, with 19 segments, of which the basal are as small as the basal segments of P_2. The first segment is short, more or less crescentic, the second is about twice as broad as the median length, the third is not quite so long as the distal breadth, the fourth is from one third to one half again as long as broad, and the following gradually increase in length, after the eighth being three or four times as long as broad; the fifth and following have slightly produced and spinous distal edges.

P_3 is 10 or 11 mm. long, similar to P_b. P_c is 8 mm. long, with 17 segments, slenderer than P_b and with more elongated segments. P_4 is similar to P_c. P_d is 7 mm. long, with 18 segments, resembling P_c but even more delicate and with longer segments. P_5 is similar to P_d. P_e is 6.5 mm. long, with 16 segments, and resembles P_d. P_6 is similar to P_e. The distal pinnules are excessively slender, 8.5 mm. long, composed of 20 segments.

Each ambulacral lappet contains usually two similar smooth spicules, an outer and an inner, the adjoining ends of which overlap more or less; each is bent at an obtuse angle in the middle; the outer may be branched or forked at the outer end, or may be replaced by two or three small straight spicules irregularly arranged.

Each tentacle contains at the base a double (distal and proximal) continuous row of small spicules which soon coalesce, forming a single row which, becoming gradually narrower, is continued almost to the tip; when the tentacle is contracted this row of spicules may be more or less zigzag. These tentacular spicules are much the most conspicuous of all the perisomic deposits in the pinnules.

Locality.—*Siboga* station 167; near Misool (lat. 2°35′30″S., long. 131°26′12″E.); 95 meters; hard coarse sand; August 22, 1899 [A. H. Clark, 1912, 1918] (16, U.S.N.M., E.426; Amsterdam Mus.).

Remarks.—This very distinct species is as yet known only from the original specimens dredged by the *Siboga.*

EUDIOCRINUS PHILENOR A. H. Clark

PLATE 10, FIGURES 37, 38

Eudiocrinus philenor A. H. CLARK, Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 554 (*Investigator* station 534; description), pl. 19, figs. 1–4.

Diagnostic features.—The cirri are long and slender but do not taper distally; they are composed of 13–15 segments of which the longest are three and one-half to four times as long as broad, and the distal are about twice as long as broad; the enlarged proximal pinnules are not especially long; the arms are about 40 mm. long, and the cirri are 10 mm. long.

Description.—The centrodorsal is discoidal, thin, with a rather broad, flat, and more or less rugose polar area. In small specimens the dorsal pole is more or less strongly convex. The cirrus sockets are arranged in a crowded zigzag row, alternating higher and lower; rarely there are two sockets one above the other.

The cirri are XX–XXV, 13–15 (usually 14), 10 mm. long, slender and delicate and only moderately curved. The first segment is very short, the second is longer, about twice as broad as long or somewhat shorter, the third is half again as long as the median width, the fourth is about three and one-half times as long as the median width, and the three following are about four times as long as the median width; the segments succeeding slowly decrease in length so that the antepenultimate is about twice as long as broad and the penultimate is about as long as broad or slightly longer than broad. The third segment is rather strongly constricted centrally. The next few segments are moderately constricted centrally, and those succeeding have a slightly concave ventral profile, but soon a less strongly concave dorsal profile. The antepenultimate segment is practically oblong in lateral view. The opposing spine is prominent and sharp, terminally situated, and is equal in height to about half the distal width of the penultimate segment. The terminal claw is about as long as the penultimate segment or slightly longer, and is slender and moderately and evenly curved.

The gently concave distal edge of the radials extends slightly beyond the rim of the centrodorsal. The syzygial pair formed by the two elements of the IBr series is oblong and half again as broad as long. The IBr_1 has a low and broadly rounded elevation occupying the median line. The IBr_2 has a corresponding but somewhat less strongly marked midradial elevation, and the distal edge is slightly everted.

The five arms are about 40 mm. long. The first brachial is short, oblong, about four times as broad as long, of about the same size as the IBr_1 and with a similar midradial elevation. The distal border is slightly everted. The second brachial is slightly larger than the first, and is trapezoidal in shape; it bears a slight median elevation in the proximal half or two-thirds, and the distal edge is slightly everted. The syzygial pair formed by brachials 3+4 is slightly longer on the side bearing the pinnule than on the opposite side, and is not quite twice as broad as long. The hypozygal is oblong, nearly four times as broad as long, and the epizygal is longer on the side toward the pinnule base than on the opposite side, in the midradial line being of the same length as the hypozygal. The next two brachials are very bluntly wedge-shaped, about two and one-half times as broad as the midradial length. After the second syzygy the brachials become triangular, as long as or somewhat longer than broad, but soon wedge-shaped again with less oblique ends, later becoming longer with slightly concave sides. The brachials as far as the second syzygy have a low and broadly rounded tubercle in the proximal portion. The succeeding brachials have the middle of the dorsal line almost imperceptibly elevated.

Syzygies occur between the elements of the IBr series, between brachials 3+4, 8+9, and 13+14, and distally at intervals of 3 muscular articulations.

P_C is 4 mm. long, with 11 segments, of which the first is short and trapezoidal, half again as broad as the greater (inner) length, the second is almost oblong, twice as broad as the median length, the third is about as long as broad, the fourth is half again as long as the median length, and those following slowly increase in length, becoming nearly three times as long as broad terminally. The third and following segments have the distal edge very slightly everted. The pinnule is moderately stout at the base and tapers evenly to the tip. The middorsal line is very obscurely and roundedly elevated, scarcely suggesting the carination found in related species. P_1 is 4 mm. long, with 12 segments, and resembles P_C. P_a is 8 mm. long, with 15 segments, roughly half again as broad at the base as P_C, moderately slender and tapering evenly to a fine tip. It is somewhat flattened laterally and is broadly rounded dorsally, not being prismatic. The first segment is from half again to twice as broad as long, the second is slightly broader than long, the third is slightly longer than broad, the fifth is twice as long as the median width, and the eighth or ninth and following are about three times as long as broad. The longer segments are very slightly constricted centrally, and the distal ends are slightly prominent and are armed with exceedingly fine spines.

Locality.—*Investigator* station 534; Mergui Archipelago, west of Tavoy Island (lat. 12° 59′ N., long. 96° 48′ 30″ E.); 110 meters; coral and sand; April 17, 1913 (14, U. S. N. M.; I. M.).

Remarks.—This species is more or less intermediate between *E. junceus*, in which the cirri are greatly elongated, slender, composed of usually 22 greatly elongated segments, and taper gradually from the base to the tip, and the other species of the genus in which the cirri are much shorter and are composed of fewer segments of which the longest are never more than twice as long as broad and the distal are about as long as broad. It seems to be most closely related to *E. ornatus* from which it differs in having the cirri more slender with more elongated segments, in the longer P_a and P_2, in having the ossicles of the IBr series and the earlier brachials distinctly, though roundedly, carinate, and in having the distal edge of the earlier brachials much less produced.

EUDIOCRINUS PINNATUS A. H. Clark

Plate 11, Figure 39

[See also vol. 1, pt. 1, fig. 84 (side view), p. 137; pt. 2, fig. 787 (ambulacral deposits), p. 366.]

Eudiocrinus pinnatus A. H. Clark, Proc. Biol. Soc. Washington, vol. 25, 1912, p. 27 (description; *Siboga* Station 310); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. ix (relationship with *E. variegatus*), p. 64 (in key; range), p. 67 (references; detailed description; station 310), p. 68, fig. 4, p. 276 (listed), pl. 17, fig. 30.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 73 (compared with *E. loveni*).—A. H. Clark, Temminckia, vol. 1, 1936, p. 295 (listed), p. 300 (*Snellius* station 123*; notes).

Diagnostic features.—The cirri are short and stout, with none of the component segments longer than broad; P_a and P_2 are elongated and stiffened, but slender like the succeeding pinnules and not enlarged, with the third and fourth segments half again as long as broad; these pinnules are one-third or one-fourth again as long as the pinnules following, and are composed of 16 or 17 segments.

The short, stout, short-segmented cirri distinguish this species from all the others in the genus except *E. variegatus* and *E. loveni*. From *E. variegatus* it is distinguished by the slenderness of P_a and P_2, which have longer proximal segments, and from *E. loveni* it is distinguished by the fact that these pinnules are markedly longer than those succeeding and are composed of 16 or 17 instead of only 11 segments.

Description.—The centrodorsal is discoidal, with the flat dorsal pole 2 mm. in diameter. The cirrus sockets are arranged in two marginal rows.

The cirri are XVII, 17–22, from 10 to 11 mm. long; all the segments beyond the third are subequal, none being quite so long as broad; the fourth-eighth or -ninth have slightly prominent distal edges, especially dorsally. The cirri are rather stout and are of the same type as those of *E. variegatus*.

The five arms are about 75 mm. long; the brachials are unornamented, and their distal edges are not produced.

P_C is 4 mm. long, moderately stout, strongly prismatic, evenly tapering to the tip, the distal border of the segments sharply, though narrowly, carinate, composed of 11 segments. P_1 similar to P_C, 4.5 mm. long, with 12 segments. P_a is 11 mm. long, with 17 segments, very slender like the succeeding pinnules, though very stiff. The first two segments are slightly broader than long, the third and fourth half again as long as broad, and the following gradually increase in length, becoming distally three or four times as long as broad; distal edges of the third and following segments are produced and spinous. The pinnule resembles the lower pinnules in certain of the more slender species of *Colobometra.* P_1 is similar to P_a, 11 mm. long, with 17 segments. P_b is similar to P_3, 8 mm. long, with 18 segments. P_3 is 8 mm. long, with 18 segments, proportionately slenderer than P_2 and with much shorter segments, which become as long as broad on the third and twice as long as broad basally on the tenth or eleventh. P_c and P_4 are 7.5 mm. long, with 18 segments, and resemble the preceding pinnules; the distal pinnules are 12 mm. long, with 20–24 segments, which, beyond the fifth, are twice, and distally three times, as long as broad, with very finely spinous distal ends.

The deposits along the ambulacra in this species are essentially the same as in *E. junceus.*

Notes.—The preceding description was drawn up from the type specimen from *Siboga* station 310.

The arms in the six specimens from the Danish Expedition to the Kei Islands station 54 are up to 55 mm. in length.

The specimen from off Jolo in about 46 meters may be thus described: The centrodorsal is thin discoidal with a broad flat dorsal pole; the cirrus sockets are arranged in a single regular marginal row. The cirri are XV, 17, moderately stout and strongly curved. The first two segments are more than twice as broad as long, and those following are all about as long as broad, the fourth being sometimes, but not always, slightly longer than broad. The third and fourth segments are rather strongly constricted centrally, and the two following have somewhat flaring distal ends. The opposing spine is prominent, conical, with the apex median, and rises to a height equal to half the width of the penultimate segment. The terminal claw is slightly longer than the penultimate segment, rather stout, and strongly and usually evenly curved. The radials have a slightly and very finely roughened distal border. The brachial structure resembles that of *E. indivisus.* The distal edges of the brachials are very finely spinous but are not produced.

P_C is about 6 mm. long and is composed of 15 segments; it tapers evenly from a fairly broad base to the tip. The first two segments are much broader than long, the fourth is about as long as broad, and the remainder are about half again as long as broad. The pinnule is not obviously prismatic, the dorsal ridge being so broadly rounded as scarcely to be evident. Each of the first five segments bears a conspicuous sharp carinate process with the crest straight and parallel to the longitudinal axis of the pinnule. On the first segment this crest occurs only in the distal half, but it occupies the entire side of the other segments. It is highest on the second–fourth segments, lower on the fifth, and very low on the sixth. P_1 is very slightly longer than P_C and also stouter. It is composed of 14 segments, which become about as long as broad on the fourth and half again as long as broad distally. The first four segments bear conspicuous carinate processes resembling those on the corresponding segments of P_C. P_a, situated on the epizygal of the first brachial syzgyial pair, is 12 mm. long, stiffened and more or less spinelike, stouter basally than P_1, and tapering very slowly. It is composed of 16 segments of which the first is trapezoidal, somewhat broader than long, the second is nearly oblong, not quite twice as broad as long, the third is somewhat longer than broad, and those following increase in length becoming nearly 3 times as long as broad near the tip. The pinnule is not carinate but is strongly rounded dorsally. The third and following segments have the distal edge bordered with fine spines, which increase in size on succeeding segments. There is no trace of carination on the earlier segments. P_2 resembles P_a. This pair of pinnules stands out in marked contrast to the other pinnules. P_b is 7 mm. long, with 17 segments. It is less stout basally than the preceding pinnules, tapers to a delicate tip, and is flexible. Only the five terminal segments are longer than broad. The segments have produced and spinous distal ends. The following pinnules are very small and weak.

In the specimen from *Willebrord Snellius* station 123* the cirri are XVII, 13–14, 5 mm. long. The first segment is very short, the second is twice as broad as long, the third is half again as broad as long, and the remainder are about as long as the width of their distal ends. The segments are slightly constricted centrally, this constriction becoming obsolete in the distal fourth of the cirri. The opposing spine is slender, sharp, erect, and subterminal, and is equal in height to about half the width of the penultimate segment. The terminal claw is about as long as the penultimate segment and is rather stout and strongly curved. The radials have their distal border strongly and irregularly tuberculated. All the segments of P_C and P_1 have high thin-lobed or coarsely serrate carinate processes that decrease in height toward the pinnule tip. P_a and P_1 are 3.5 mm. long, with 11 segments, and are slender. The first segment is crescentic, almost semicircular, twice as broad as long, the second is oblong, twice as broad as long or even broader, the third is half again as long as broad, and those following increase in length, becoming twice as long as broad distally. The second and following segments have the distal edges spinous, especially at the prismatic angles, this spinosity increasing distally. P_b resembles P_a. P_2 and the following pinnules are somewhat shorter and weaker, though only very slightly less stout. This specimen appears to represent *E. pinnatus*, differing from the type specimen only in features attributable to its smaller size.

Localities.—*Siboga* station 310; north of the eastern end of Sumbava, Lesser Sunda Islands (lat. 8° 30′ S., long. 119° 07′ 30″ E.); 73 meters; sand with a few pieces of dead coral; February 12, 1900 [A. H. Clark, 1912, 1918] (1, Amsterdam Mus.).

Danish Expedition to the Kei Islands station 53; Dr. Th. Mortensen; 85 meters; sand and coral; May 9, 1922 (1).

Danish Expedition to the Kei Islands station 54; Dr. Th. Mortensen; 85 meters; sand and coral; May 9, 1922 (6).

Dr. Th. Mortensen's Pacific Expedition, 1914–1916; off Jolo (Sulu); about 46 meters; sand and coral; March 19, 1914 (1).

Willebrord Snellius station 123*; lat. 10° 29′ 00″ S., long 126° 44′ 00″ E.; about 100 meters; October 28, 1929 (1, L. M.).

Geographical range.—From the Lesser Sunda to the Kei and Philippine Islands.

Bathymetrical range.—From 46 to 85 meters.

Remarks.—This species is as yet known only from the 10 specimens listed above.

EUDIOCRINUS LOVENI Gislén

Eudiocrinus loveni Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 4 (145 m.), p. 6 (Bonin Islands), p. 7, p. 72 (description; Bock's station 47; comparisons), p. 182 (listed), figs. 53–56, p. 70, pl. 1, fig. 6; Zool. Bidrag Uppsala, vol. 9, 1924, p. 41 (measurements; details of arm structure), p. 42 (brachial angles), p. 285 (Bonin Islands, 144 m.; details), fig. 9, p. 45 (arm base).

Diagnostic features.—The cirri are short and stout, with none of the component segments longer than broad; P_a and P_2 are elongated and stiffened, but slender like the pinnules succeeding and not enlarged, with the third and fourth segments half again as long as broad and the distal segments three or four times as long as broad; these pinnules are of the same length as the succeeding pinnules and are composed of 11 segments.

The short, stout, short-segmented cirri distinguish this species from all the others in the genus except *E. variegatus* and *E. pinnatus*. From *E. variegatus* it is distinguished by the slenderness of P_a and P_2, which are composed of longer segments, and from *E. pinnatus* it is distingushed by the fact that these pinnules are of the same length as those succeeding and are composed of only 11 segments.

Description.—As described by Gislén the centrodorsal is 1.8 mm. in diameter.

The cirri are XX, 20–21, from 9 to 10 mm. long. The first two segments are broader than long, the third is about as long as broad, and the fifth–seventh are one-quarter again as long as broad. The segments are smooth, slightly constricted centrally, and rather stout. The height of the opposing spine is two-thirds the width of the penultimate segment. The terminal claw is curved, and is as long as the penultimate segment.

The radials are visible as narrow smooth bands about 5 times as broad as long. The syzygial pair formed by the elements of the IBr series is as long as broad with rather pronounced ventrolateral ledges.

The five arms are 40–45 mm. long and are smooth. The first brachial is 1.4 mm. in width.

P_C is 3.5 mm. long and is composed of nine segments. The first segment tapers strongly distally, and the second segment is the broadest. The first three or five segments have a distally directed crest of which the height is equal to one-third the width of the segments. P_1 is 4 mm. long, with 10 segments and is similar to P_C. P_a is 5 mm. long, with 11 segments, of which the third is half again as long as broad and the distal are two or two and one-half times as long as broad with a somewhat spiny distal edge. P_2 is 5 mm. long, with 11 segments. P_b is 5 mm. long with 12 segments, P_3 is 5 mm. long with 11 segments of which the distal have a small spiny wreath. The distal pinnules are 4.5 mm. long, with 16 or 17 segments which are three times as long as broad and of which the last three bear dorsal hooks. Each segment bears four pairs of large sacculi.

As preserved in alcohol the arms are dorsally brown with white transverse spots, and the pinnulars are whitish with the sacculi darker. The cirri are white.

Notes.—Dr. Gislén said that at first he had some doubt whether this specimen represented a distinct species or was merely a fully grown individual of the type he described as *E. gracilis pulchellus.* But he pointed out that some of the differences between the two are of such a nature as to oblige him to believe that they cannot be due simply to age. He listed the most important differences as follows: The cirrus segment are short, not very much longer than broad, and are not at all or only slightly constricted centrally, as in *E. pinnatus* and *E. variegatus.* The proximal segments of P_C and P_1 bear prominences that are lacking on the corresponding pinnules in *E. gracilis pulchellus.* In the possession of these prominences it approaches *E. venustulus. Eudiocrinus loveni* further differs from *E. gracilis pulchellus* in having the arms, though of about the same length, much stouter, in the more spiny borders of the distal segments of P_2 and P_3, and in the relatively short distal pinnules.

Locality.—Dr. Sixten Bock's Expedition to Japan station 47; Bonin Islands, east of the Channel; 146 meters; August 1, 1914 [Gislén, 1922].

Remarks.—This species is as yet known only from the single specimen described by Gislén.

EUDIOCRINUS VARIEGATUS A. H. Clark

PLATE 11, FIGURE 41

[See also vol. 1, pt. 2, fig. 127 (arm base), p. 79; fig. 266 (arm), p. 207.]

Eudiocrinus variegatus A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (*nomen nudum;* belongs to same type as *E. indivisus* and *E. granulatus;* arm structure); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 277 (listed), fig. 8, p. 277 (centrodorsal and base of an arm), pp. 278, 279, figs. 9–11 (description; 34°59′ N., 139°34′ E., 60 fathoms), p. 307 (recorded); Proc. Biol. Soc. Washington, vol. 25, 1912, p. 27 (compared with *E. pinnatus*); Crinoids of the Indian Ocean, 1912, p. 102 (synonymy; habitat); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (southern Japanese species; range and its significance); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. IX (relationship with *E. pinnatus*), p. 64 (in key; range).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 68, 73 (compared with *E. loveni*).

Eudiocrinis variegatus A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 12 (no locality; description).

Diagnostic features.—The cirri are short and stout, with none of the component segments longer than broad; P_a and P_2 are enlarged and are composed of 11 or 12 segments of which the first four are broader than long, and the outer are about twice as long as broad.

This species is distinguished from *E. pinnatus* and *E. loveni,* which have similar short, stout, short-segmented cirri, by the stout and short-segmented P_a and P_2.

Description.—The centrodorsal is discoidal, rather thick, with somewhat convergent sides and a broad, flat polar area. The cirrus sockets are arranged in two crowded and more or less irregular rows.

The cirri are about XXV, 15, from 7 to 9 mm. long. The first segment is about twice as broad as long, and the remainder are about as long as their distal width. The fourth and fifth segments have their distal ends considerably swollen and projecting somewhat dorsally, this feature becoming gradually less and less marked distally, where the segments are somewhat compressed laterally. There are no dorsal spines. The opposing spine is prominent, erect, and median, arising from the entire dorsal surface of the penultimate segment. The terminal claw is rather stout and well curved and is about as long as the penultimate segment.

The distal edges of the radials are even with the rim of the centrodorsal. The IBr_1 are short, oblong, about four times as broad as long, with a well-marked median tubercle. The IBr_2 are slightly longer than the IBr_1, though similar. These two ossicles together form a syzygial pair, which is nearly twice as broad as long, with the lateral edges slightly turned outward.

The five arms are 75 mm. long. The first and second brachials are slightly over twice as broad as long with the distal edges rather prominent and with a rounded median tubercle; their lateral edges, like those of the IBr_1 and IBr_2, are slightly turned outward, forming a narrow lateral border. The first syzygial pair (composed of brachials 3+4) is not quite so long as broad, slightly longer on one side than on the other, and bears a low rounded median keel. The next two brachials are wedge-shaped, not so long as broad, and those following are triangular, about as long as broad, soon becoming obliquely wedge-shaped and longer than broad, and distally elongate and less obliquely wedge-shaped. The brachials as far as the sixth or seventh have a low rounded median keel marked by a series of longitudinally elongate tubercles, one on each brachial. From this point onward the keel becomes less evident and assumes a zigzag course. It is traceable to at least the distal third of the arm. The distal ends of the brachials in the proximal portion of the arm project somewhat, but this feature dies away after about the middle of the arm.

Syzygies occur between brachials 3+4, 8+9, and 13+14, and distally at intervals of 3 muscular articulations.

P_C is 4 mm. long, stout and prismatic, composed of nine segments, which are about as long as broad. P_1 is similar to P_C but much stouter, 6 mm. long with 12 segments, of which the first three are about as long as broad and the remainder are longer than broad, though not elongated; the pinnule is rounded and all the segments overlap strongly and have serrate distal ends. P_a resembles P_1. The pinnules following are about 4.5 mm. long, much more slender than those preceding, with about 12 segments of which the first is very short, the next two are about as long as broad, and the remainder are elongate with the articulations somewhat swollen and the lower segments with overlapping and spinous distal ends. The distal pinnules are 9 mm. long, slender, with the first segment short, the second about as long as broad, and the remainder much elongated with expanded articulations.

The disk is lacking. Sacculi are abundant and large on the pinnules, less abundant and smaller along the brachial ambulacra.

The color is purplish brown, lighter dorsally, the arms and pinnules banded with purple and whitish, the cirri white, and the enlarged pinnules (P_1 and P_a) purple.

Notes.—A rather small and immature specimen in the Hamburg Museum may be described as follows: The centrodorsal is thin discoidal with a flat dorsal pole 1 mm. in diameter. The cirri are arranged in a single irregular marginal row. The cirri are XVII, 14–15, 5 mm. long. The fourth and fifth segments are the longest, very slightly longer than the proximal width. The second-fifth segments are centrally constricted with widely flaring distal ends which project strongly dorsally; this feature rapidly decreases distally and disappears after the eighth. The distal border of the radials is slightly swollen, and is smooth or finely beaded. The proximal border of the IBr_1 is slightly everted and bears a small but prominent median tubercle; the distal edge is also everted, the eversion being thickened and slightly produced in the center. The five arms are 40 mm. long. The proximal oblong brachials have the distal edges very slightly turned outward and slightly thickened in the center. The arms beyond the proximal discoidal brachials have a smooth dorsal line and apparently lack the usual zigzag carination.

The pinnules of the first pair are 3 mm. long and consist of nine segments, which at first are short, becoming about as long as broad on the third and nearly three times as long as broad distally. The first segment has a high rounded carinate process, which is nearly half as high as the width of the segment. The second has a carinate process, which is not quite so high and which has a straight distal border parallel to the longitudinal axis. The third has a carinate process similar to that of the second, but smaller. The following segments are without carinate processes and therefore appear more slender. The pinnules of the second pair are 4 mm. long and consist of 11 or 12 segments. They are stiffened but are only slightly enlarged. The first segment is twice as broad as the median length, and has the distal angle very slightly produced. The second is slightly broader than the median length, but not quite so broad as the first. The third is half again as long as broad, only about half as broad basally as the first. The fourth is similar to the third but longer, twice as long as broad. The following segments slowly increase in length to about three times as long as the proximal width, the terminal one or two being small as usual. The distal edges of the third and following are produced and spinous, the spines being especially long on the prismatic angles. The pinnules as a whole are rounded prismatic and taper regularly from the third segment to the tip. The pinnules of the third pair are 3 mm. long and are composed of 11 segments. They resemble those of the second pair, but are more slender with more elongated distal segments. The pinnules of the fourth pair are very slender, weak, and delicate, not stiffened, about 3 mm. long, with 10 or 11 segments, which at first are short, becoming half again as long as broad on the third, twice as long as broad on the fourth, and four times as long as broad distally. The third and following have produced and spinous distal ends. The distal pinnules are exceedingly slender, 7 mm. long with 15 or 16 segments of which the third and following are greatly elongated with produced and spinous distal edges. The disk is completely plated.

Localities.—Sagami Bay, Japan (lat. 34°59′ N., long. 139°34′ E.); 110 meters [A. H. Clark, 1908, 1912, 1915, 1918; Gislén, 1922] (1, U. S. N. M., 25326 [Owston Coll. No. 6931]).

No locality; C. Eberstein [A. H. Clark, 1912] (1, H. M.).

History.—This species was first mentioned, as a *nomen nudum*, in my paper on new genera of unstalked crinoids, published on April 11, 1908. The occurrence of a single specimen in the Owston collection of Japanese crinoids, which had been purchased and presented to the U. S. National Museum by Frank Springer, had enabled me to understand the proximal arm structure and to show that in this species, and also in the related *E. indivisus*, which I had not then seen, the first two ossicles following the radials are homologous with the elements of the IBr series in 10-armed forms.

Having at hand specimens of the species described by Dr. P. H. Carpenter as *Eudiocrinus varians* and *E. japonicus*, as well as of my own recently described *E. tuberculatus*, I was able to demonstrate that in these species the IBr series are wholly lacking, the first two ossicles following the radials being the equivalent of the first two ossicles following the IBr axillary in 10-armed forms. The species in which IBr series are present although the IBr_2 is not axillary (*variegatus* and *indivisus*) I retained in the genus *Eudiocrinus*, while those species that lack the IBr series altogether I removed to the new genus *Pentametrocrinus*, assigning to this new genus the species previously known as *Eudiocrinus atlanticus*, *E. japonicus*, *E. semperi*, *E. tuberculatus*, and *E. varians*.

The species was first described, and figures showing the lower pinnules and a cirrus were given, in a paper written before that just mentioned, although it was not published until June 20, 1908. In this paper a very detailed comparison of the structure of the species of *Eudiocrinus* and of those of *Pentametrocrinus* is given.

In 1912 I published a description of a rather small and immature specimen without locality that I had examined in the Hamburg Museum.

EUDIOCRINUS VENUSTULUS A. H. Clark

PLATE 12, FIGURES 45, 46

[See also vol. 1, pt. 2, fig. 191 (side view), p. 112.]

Eudiocrinus venustulus A. H. CLARK, Proc. Biol. Soc. Washington, vol. 25, 1912, p. 27 (description; *Siboga* station 289); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 65 (in key; range), p. 68 (references; detailed description; Stas. 289, 294; *Albatross* station 5355), p. 275 (listed), pl. 17, figs. 27, 28.—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 7, 73 (compared with *E. loveni*).—A. H. CLARK, Temminckia, vol. 1, 1936, p. 295 (listed), p. 302 (*Snellius* station 60*; notes).

Diagnostic features.—This small and slender species is readily distinguished from all the other species in the genus by the large spatulate or fan-shaped process on the first segment of P_C.

Description.—The centrodorsal is thin-discoidal, with the bare dorsal pole flat, finely papillose, 1.0 mm. in diameter. The cirrus sockets are arranged in a single marginal row.

The cirri are XII, 15–16, 6.5 mm. long, rather slender. The first segment is short, the second is longer, the third is about as long as the median diameter, and the fifth and sixth are the longest, about as long as the distal diameter or slightly longer. The segments after the eighth are subequal, slightly longer than broad. The third-seventh segments are constricted centrally with strongly expanded distal ends, which overlap the bases of the succeeding segments, especially dorsally; beyond the seventh this character gradually dies away.

The distal border of the radials is just visible beyond the edge of the centrodorsal, and is ornamented with a row of small regular tubercles. The ossicles of the IBr series (united in a syzygial pair) taken together form an element which is oblong, not quite twice as broad as long, with the proximal, distal, and lateral edges everted; the lateral edges are beaded like the distal edge of the radials; the proximal edge is faintly scalloped and bears a prominent median tubercle; the distal edge has the median third of the eversion thickened and standing up vertically as a high transverse ridge; the syzygial line is finely beaded.

The five arms are 60 mm. long. The first brachial is oblong, about three times as broad as long, with the proximal edge slightly everted and bearing a prominent, though small, median tubercle, and the distal edge is strongly everted and thickened, this thickened and everted border being more or less divided in the middle. The second brachial is very slightly larger than the first, about twice as broad as long, with the distal edge everted, the central third of this eversion being thickened and produced. The first syzygial pair (composed of brachials 3+4) is about as long as broad or slightly longer than broad, with the proximal edge slightly everted and bearing a a minute median tubercle, and the distal edge slightly everted with a somewhat larger, more or less transversely elongate, median tubercle. The following brachials have finely spinous distal ends, which are not produced or everted; a slight median tubercle is visible on the proximal border of the brachials as far as the first or second beyond the second syzygy; there is a very low and faint median carination on the syzygial pair and on the following brachials, which is accentuated by being light in color bordered with dark on each side; on the triangular brachials this becomes zigzag as in the other species of the genus.

P_C is 3 mm. long and is composed of 10 segments, of which the first bears a very large fan-shaped, rounded, or distally truncated carinate process about as high as the lateral height of the segment, and the second bears a high carinate process half as high as the lateral height of the segment, of which the crest is parallel to the longitudinal axis of the pinnule. The following segments are similarly, but diminishingly, carinate. P_1 is similar. P_a is 5 mm. long, with 11 or 12 segments, of which the first is short, the second is nearly as long as broad, the third is about as long as broad, and the distal are twice as long as broad; the pinnule is rather slender, not greatly enlarged, and rather strongly prismatic; the distal edges of the third and following segments are slightly produced and finely spinous, with prominent spines at the angles of the prism; the ventral borders bear very numerous fine spines; the first segment has a strongly rounded carinate process, and the second and third are narrowly, though sharply carinate. P_2 is similar to P_a. P_b is 4 mm. long, with 13 segments, slightly slenderer than P_a; the first segment is short, the second is slightly longer, and the third is about as long as broad; the distal segments are much elongated with a few long spines on the distal edges, which are turned outward; the proximal segments are not carinate. The following pinnules are similar, though weaker and more slender with the distal segments slightly longer and bearing a few conspicuous spines on their overlapping distal ends. The distal pinnules are exceedingly slender, 7 mm. long, with 17 segments, of which the third and following are greatly elongated; the third bears a narrow carination.

The perisomic deposits along the ambulacra in this species do not differ essentially from those in *E. junceus*.

Notes.—The three specimens from the Danish Expedition to the Kei Islands station 54 have the arms up to 45 mm. in length.

In the specimen from *Willebrord Snellius* station 60* the production of the ends of the ossicles of the division series and proximal brachials is exaggerated, and on the radials and IBr_1 is resolved into numerous closely set prominent tubercles which are expecially long in the interradial angles. The rim of the centrodorsal is also tubercular.

Localities.—*Albatross* station 5355; north Balabac Strait; Balabac Light bearing S. 61° W., 16.6 miles distant (lat. 8°08′10″ N., long. 117°19′15″ E.); 80 meters; coral and sand; January 5, 1909 [A. H. Clark, 1918] (2, U. S. N. M., 36009).

Danish Expedition to the Kei Islands, station 54; Dr. Th. Mortensen; 85 meters; sand and coral; May 9, 1922 (3).

Danish Expedition to the Kei Islands, station 57; Dr. Th. Mortensen; 85 meters; sand and coral; May 9, 1922 (2).

Siboga station 289; off the southern coast of Timor (lat. 9°00′18″ S., long. 126°24′30″ E.); 112 meters; mud, sand, and shells; January 20, 1900 [A. H. Clark, 1912; 1918] (3, Amsterdam Mus.).

Siboga station 294; off southwestern Timor (lat. 10°12′12″ S., long. 124°27′18″ E.); 73 meters; soft mud with very fine sand; January 23, 1900 [A. H. Clark, 1918] (55, U. S. N. M., E. 475; Amsterdam Mus.).

Willebrord Snellius station 60*; lat. 6°58′00″ N., long. 121°52′30″ E.; 72–80 meters; September 5, 1929 (1, L. M.).

Geographical range.—From the Philippines to the Kei and Lesser Sunda Islands.

Bathymetrical range.—From 73 to 112 meters.

History.—This species was first described by me in 1912 from three specimens from *Siboga* station 289. It was redescribed and figured in 1918, when it was recorded also from *Siboga* station 294 and *Albatross* station 5355. In 1936 it was recorded from *Willebrord Snellius* station 60*.

EUDIOCRINUS EOA, sp. nov.

Diagnostic features.—The slender and strongly recurved cirri composed of only 11 or 12 segments, of which the longest are about two and one-half times as long as the median width and the antepenultimate is half again as long as broad, distinguish this species from all the others in the genus.

Description.—The centrodorsal is thin discoidal with a broad flat dorsal pole. The cirrus sockets are arranged in a single fairly regular marginal row.

The cirri are XV, 11–12, very slender, strongly recurved, and composed of segments all of which except the basal are longer than broad. The first segment is about twice as broad as long, the second is about twice as long as the median width, the third-sixth or -seventh are about two and one-half times as long as the median width, and those following slowly decrease in length so that the antepenultimate is half again as long as broad and the penultimate is slightly longer than broad. The second segment is rather strongly constricted centrally, the third much less so, and on those following the constriction is still less, finally disappearing at about the middle of the cirri. The opposing spine is represented by a minute terminal tubercle. The terminal claw is somewhat longer than the penultimate segment, and is rather strongly and evenly curved. The IBr series are rather deeply constricted at the syzygial line. In the earlier portion of the arms the central part of the ends of the brachials is slightly thickened, but this disappears after the basal third.

P_c is short, stout, strongly prismatic, and tapers rapidly and evenly to the tip; it is 2.5 mm. long and is composed of eight segments. P_1 resembles P_c. P_a is 4 mm. long, about as stout basally as P_c, but tapers more gradually to a slender tip.

Locality.—Dr. Th. Mortensen's Pacific Expedition, 1914–1916; off Jolo (Sulu); about 46 meters; sand and coral; March 19, 1914 (1, C. M.).

Remarks.—As yet this species is known only from the type specimen.

EUDIOCRINUS INDIVISUS (Semper)

Plate 11, Figure 42

Ophiocrinus indivisus Semper, Archiv für Naturg., 1868, vol. 1, p. 68 (description; Pandanon, 30 fathoms).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 573 (type of *Eudiocrinus*), p. 574 (first reference and type locality); vol. 34, 1908, p. 271 (history; original description quoted); Crinoids of the Indian Ocean, 1912, p. 3 (history).

Eudiocrinus indivisus P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 495.—Perrier, Compt. Rend. Acad. Sci., vol. 96, 1883, p. 726; Ann. Mag. Nat. Hist., ser. 5, vol. 11, 1883, p. 294 (comparison with *E.* [*Pentametrocrinus*] *atlanticus*).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, pp. 47, 48, 58, 127, 137 (discussion).—Perrier, Mémoire sur l'organisation et le développement de la comatule de la Meditérranée, 1886, p. 106 (sacculi).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 76, 79–81, 83, 367, 374 (discussion).—Bell, Proc. Zool. Soc. London, 1894, p. 392 (type in the collection of W. Percy Sladen), p. 397 (comparison with *E. granulatus*).—Walther, Einleitung in die Geologie als historisch. Wiss., 1894, p. 299 (from Carpenter).—Pfeffer, Abh. Senck. Naturf. Ges., vol. 25, 1900, p. 85 (Ternate).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 574 (original reference and type locality).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576 (listed).—A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (belongs to same type as *E. granulatus* and *E. variegatus;* arm structure); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 271 (history; original description; structure; relationships), p. 277 (listed); vol. 35, 1908, pp. 113, 114, 117 (arm structure); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 211 (compared with *E. serripinna*); Proc. U. S. Nat. Mus., vol. 39, 1911, p. 540 (*Albatross* station 5356); Mem. Australian Mus., vol. 4, 1911, p. 715 (belongs to a family peculiarly charactristic of the Jurassic rocks of Europe); Crinoids of the Indian Ocean, 1912, p. 3 (history), p. 32 (identity), p. 38 (*E. granulatus* a synonym), p. 102 (synonymy; localities); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 21 (published reference to specimen in the B.M.; Macclesfield Bank, 34–40 fathoms; characters); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 65 (in key; range), p. 71 (synonymy; notes; stations 65*a*, 144, 257, 260, 305); *Albatross* station 5356); pp. 272, 273, 275, 276 (listed).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 4 (182 m.), p. 6 (Bonin Islands), p. 68 (Bock's station 59; detailed notes), p. 183 (listed), fig. 52, p. 70; Zool. Bidrag Uppsala, vol. 9, 1924, p. 46 (obliquity of joint faces), p. 77 (syzygies), fig. 68, p. 75 (sygygial face).—A. H. Clark, Temminckia, vol. 1, 1936, p. 301 (*Snellius* Station 60*; notes).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 3 (Macclesfield Bank), p. 6 (range).

Eudiocrinus granulatus Bell, Proc. Zool. Soc. London, 1894, pp. 396, 397 (detailed description and comparisons; Macclesfield Bank, 34–40 fms.), pl. 23, opposite p. 392.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 573 (original reference and type locality).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576 (listed).—A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (belongs to same type as *E. indivisus* and *E, variegatus;* arm structure); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 271 (history), p. 272 (relationships), p. 273, footnote (discrepancies between the original figure and description noted), p. 277 (listed); vol. 35, 1908, p. 117 (arm structure); Smiths. Misc. Coll., vol. 52, 1908, p. 211 (compared with *E. serripinna;* correction of original diagnosis); Crinoids of the Indian Ocean, 1912, p. 38 (identity); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 65, footnote 2 (synonym of *indivisus*).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 68, 69 (discussion).

Diagnostic features.—The cirri have 18–20 segments of which the longest proximal are about twice as long as broad and the outermost are about as long as broad. The arms are 80–90 mm. long. The edges of the elements of the IBr series and the proximal and distal ends of the brachials are scarcely or not at all modified. P_a and P_2 are enlarged and prismatic with up to 26 segments. The distal ends of the segments of the enlarged proximal pinnules may be finely spinous but are not otherwise modified.

Description.—The centrodorsal is discoidal, small, 2–3 mm. in diameter, with the dorsal pole flat or somewhat convex, up to 2 mm. in diameter. The cirrus sockets are arranged in a single, or more or less completely double, marginal row.

The cirri are XVI–XX, 16–20 (averaging 18), 9–15 (usually about 12) mm. long. The first two segments are short, about as long as broad or slightly broader than long, the third is slightly longer, about as long as broad or a trifle longer, and the fourth- or fifth-sixth or -seventh are the longest, half again to twice as long as broad. The segments following decrease in length, the distal being about as long as broad or slightly longer than broad. The longer earlier segments are strongly constricted centrally with swollen and prominent ends, this feature diminishing on the distal segments, which are somewhat compressed laterally with the distal ends more prominent on the dorsal than on the ventral side. The opposing spine is stout and prominent, and its height is equal to about one-third the width of the penultimate segment.

The radials are almost entirely concealed by the centrodorsal; their distal border may be plain, or it may be adorned with small tubercles. The syzygial pair representing the IBr series is about three times as long as the radials. The elements of the IBr series bear a weak median prominence.

The five arms are 25–95 (averaging 70) mm. in length and are composed of about 120 brachials. The first brachial is short and oblong and bears no pinnule, and the next four or five are nearly oblong, slightly shorter on one side than on the other, the longer side being shorter than the width and bearing a pinnule. The eighth and following brachials have more markedly unequal sides, the longer of which is longer than the width. The brachials in the middle of the arm are nearly square, and the terminal brachials are elongated. Feeble articular tubercles are sometimes evident. There may be ventrolateral rows of small tubercles as far as the fourth brachial.

Syzygies occur between brachials 3+4, 8+9, and 13+14 (rarely between brachials 12+13) and distally at intervals of 3 muscular articulations.

P_c is 4 mm. long with 10–12 short segments of which the basal are rather broad. P_1 is similar to P_c but usually slightly longer and stouter. P_a is 6–7.5 mm. long, with 10–17 (usually 10–12) segments, very much longer than the preceding pinnules, with longer and more massive segments. P_2 is 6–8 mm. long and resembles P_a. P_b and P_3 are much slenderer than the preceding pinnules and have the outer segments from two and one-half to three times as long as broad. The distal pinnules are about 9 mm. long with 15 segments. The pinnules from P_c to P_2 are extraordinarily stout and thick and are sharply triangular in cross section. The third segment of P_1 and P_a is about as long as broad, and the distal segments are three-quarters again as long as broad, without distal spiny edges.

The disk is completely plated, entire, and up to about 3 mm. in diameter. Sacculi are fairly closely set on the arms, but much larger and more closely set along the sides of the pinnule ambulacra.

Notes.—In the specimen from Bock's station 59, as described by Gislén, the centrodorsal is 3 mm. in diameter with the bare dorsal pole, which is somewhat convex, 2 mm. in diameter. The cirri are XIX, 19–21, from 11 to 15 mm. long, arranged in a single or double row. The first-third segments are short, the fourth-seventh are from half again to twice as long as the median breadth, and the distal segments are shorter. The antepenultimate is not very much longer than broad. The fourth-seventh and following segments are strongly constricted centrally, the fourteenth-eighteenth becoming less swollen at the ends. The opposing spine equals in height one-third the width of the segment. The terminal claw is somewhat longer than the penultimate segment. The radials are almost entirely concealed; the visible distal border is adorned with small tubercles. The elements of the IBr series have a weak median prominence. The arm bases are smooth, without the longitudinal prominences seen in *E. variegatus*. There is a prominence between the second and third brachials, formed in the oblique articulation on the right. There is a similar prominence on the left between the fourth and fifth brachials, and one on the right between the fifth and sixth brachials; the prominences then become less pronounced. There are small ventrolateral rows of tubercles as far as the fourth brachial. The width of the first brachial is 1.9 mm. Syzygies occur between brachials 3+4 and 8+9.

P_c is 4 mm. long with 10 segments. P_1 is also 4 mm. long with 10 segments. P_a is 7.5 mm. long with 10 segments. P_2 is 8 mm. long with 11 segments. These pinnules are extraordinarily stout and thick and are sharply triangular. The third segment of P_1 and P_a is about as long as broad. The distal segments are three-quarters again as long as broad, without distal spiny borders. P_b and P_3 are much more slender, the latter having 17 segments and reaching 8 mm. in length; the segments are from two and one-half to three times as long as broad. The disk has been thrown off, but it was probably about 3 mm. in diameter. The color, as preserved, is yellow-brown.

Dr. Gislén said that this specimen is closest to *Eudiocrinus indivisus*, although the longest cirrus segments are rather short for this species. But it has cirri considerably longer than those described for *E. indivisus*, and in this respect approaches the form described as *E. granulatus* by Bell.

Professor Bell said that his new species *E. granulatus* is altogether much stouter than *E. indivisus* with longer and stronger cirri, much stronger pinnules, and a granular covering to the segments. It has an arm length of 120 mm., and the cirri are about 12 mm. long. Bell said that the arrangement and number of the cirri are as described for *E. indivisus*, but in *E. granulatus* the first two pinnules have more massive segments than the third and fourth and are quite as long, the second, indeed, being longer than the third. The other striking difference is the granulation of the surface of the arms. The ambulacral surface of the pinnules is a purplish brown, the rest of the animal being yellowish white.

Bell wrote that from the descriptions of Semper and of P. H. Carpenter, bearing in mind that they had only one specimen and he had only one, he was inclined to regard the Macclesfield Bank specimen as belonging to Semper's species. But when he put the two specimens side by side it was easy to see that the two could not be united.

In Bell's figure the cirrus shown has 20 (+1) segments of which the longest are about twice as long as broad and the distal are about as long as broad or slightly broader than long. In the figure of an arm base the lowest pinnule shown, which is apparently P_a, is about 6 mm. long and is composed of 16 or 17 segments; P_b is 10 mm. long, with 26 segments; P_c is about 8 mm. long, with 16 segments; and P_d is 7.5 mm. long. Bell figured the seventh pinnule as 8 mm. long with 17 segments, and "one of the most distal pinnules" as about 9 mm. long with 14 (+1) segments of which all but the basal are greatly elongated. Gislén has pointed out that in Bell's figure of the arm base while the pinnules are on the left side they are on brachials corresponding to P_1, P_2, and so on. P_c is not shown, and it is somewhat uncertain whether the lowest pinnule should be interpreted as P_a or P_1.

In 1908 I pointed out that in Professor Bell's description of *E. granulatus* he uses "first" and "second" pinnule in the sense of the two first pinnules on the same side of the arm, whereas Professor Semper used the same terms strictly, taking the pinnules first on one side of the arm and then on the other in their actual sequence considering the arm as a whole. Thus Professor Bell found a greater difference between the "first" and "second" pinnules in his *E. granulatus* than Professor Semper did in his *E. indivisus*, although in reality such a difference is nonexistent.

I examined the type specimen of *E. granulatus* at the British Museum in 1910. It is a large specimen, the arms measuring between 85 and 90 mm. in length. There are 18–20 cirrus segments. I could see no difference whatever between this specimen and others undoubtedly referable to *E. indivisus* from the Philippines that I had examined.

The characters of the type specimen from Bohol were given by Professor Semper as follows: The centrodorsal is small and flat, 2 mm. in diameter, with the cirri arranged in a single marginal row. The cirri are XVI, 18–20, 9 mm. long, and very knobby, especially proximally where the expansion is equal to the length of the segment. The first two segments are short, as long as broad, and the third-sixth are the longest, twice as long as broad. The outermost segments are slightly compressed laterally and smooth. The last bears, in addition to the terminal claw, a strong tooth (that is, opposing spine). The five arms are 80 mm. long. The IBr series appear to arise directly from the centrodorsal; the two elements are united by syzygy and the IBr_2 bears a pinnule. The following ossicle (first brachial) is without a pinnule. The second brachial bears a pinnule, and the third and fourth are united by syzygy, the fourth bearing a pinnule. The brachials are almost twice as broad as long, and in the middle of the arm are very obliquely wedge-shaped. The two first pinnules are small, but rather stout basally, and the third and fourth are the longest, 8 mm. long. Then follow shorter pinnules, and subsequently pinnules which gradually become longer and at the same time slenderer. The disk was lacking in the only specimen secured. The pinnules are blotched with light and dark yellow brown, and the dorsal surface of the arms is marked with two parallel zigzag lines.

Dr. P. H. Carpenter's redescription of Professor Semper's type specimen is as follows: The centrodorsal is small, convex, bearing cirri in two marginal rows, the dorsal pole being free from them. The cirri are about XX, about 20, 9 mm. long. The third segment is about as long as broad, or a trifle longer than broad. The fifth segment is the longest, and those following are nearly all longer than broad, and overlap on the dorsal side. The penultimate bears an opposing spine. The radials are partially visible, and are about one-third the length of the syzygial pair formed by the elements of the IBr series. The IBr_2 bears a pinnule on the left side. The five arms are 75 mm. long. The first brachial (third ossicle beyond the centrodorsal) is short and oblong and bears no pinnule. The next four or five brachials are nearly oblong, slightly shorter on one side than on the other, the longer side being shorter than the width and bearing a pinnule. The eighth and following brachials have more markedly unequal sides, the longer of which is longer than the width. There are about 120 brachials of which the middle ones are nearly square and the terminal are elongated. Syzygies occur between brachials 3+4, 8+9, and 13+14 (in one case 12+13) and distally at intervals of 3 muscular articulations. Carpenter expressed this as follows: "Second syzygy on the fifth brachial, the next on the ninth, and the next on the thirteenth (once on the twelfth) brachial; after this an interval of two joints between successive syzygia." P_O is quite small, consisting of about a dozen short segments of which the basal are rather broad. P_1 is somewhat longer and stouter. P_a and P_2 are very much longer and stouter, with longer and more massive segments. The next three or four pinnules on each side gradually decrease in size, and the following ones increase again, the terminal ones being very long and slender so as to give the arms a very feathery appearance. The disk has been lost, but it must have been somewhat less than 3 mm. in diameter. The sacculi are tolerably close on the arms, but much larger and more closely set at the sides of the pinnule ambulacra, which have only the very slightest trace of any superficial limestone deposits.

Carpenter said that this is a very slender and graceful little species, differing altogether in appearance from those dredged by the *Challenger* (that is, *Pentametrocrinus varians*, *P. semperi*, and *P. japonicus*).

This specimen subsequently came into the possession of W. Percy Sladen. It was later examined by Dr. P. H. Carpenter, who mentioned that the color of the skeleton was brownish white, and still later, in January 1894, it was examined by Prof. F. Jeffrey Bell, who found that it had become quite white.

The five specimens dredged by the *Albatross* at station 5356 all have the arms about 85 mm. long.

In the specimen from *Willebrord Snellius* station 60* P_a and P_2 are 7 mm. long with 12–14 segments.

The specimens from *Siboga* station 257 are small. The brachials, except the basal, show a strong production of the distal edge.

The individuals from *Siboga* station 260 have the arms 35 and 40 mm. long.

The three specimens from the Danish Expedition to the Kei Islands station 26 have the arms up to 50 mm. long. There is a tendency to an eversion of the central portion of the distal ends of the elements of the IBr series and the earlier brachials.

The two specimens from *Siboga* station 144 are small and, like those from station 257, have the brachials, except the basal, with a strong production of the distal edge.

Of the three specimens from *Siboga* station 305 one has the arms 80 mm. long, the cirri XVIII, 17, 11 mm. long, and the pinnules of the second pair 6 mm. long with 11 or 12 segments. Another has the arms 95 mm. long, the cirri XVII, 16–17, 13 mm. long, and the second pair of pinnules 7 mm. long with 12 or 13 segments. The third specimen is similar to the first.

The two specimens from *Siboga* station 65*a* are small with the arms 25 to 30 mm. long.

Localities.—Dr. Sixten Bock's Expedition to Japan station 59; Bonin Islands, eastnortheast of Anojima; 183 meters; August 15, 1914 [Gislén, 1922, 1924].

Macclesfield Bank; 62–73 meters [Bell, 1894; A. H. Clark, 1907, 1908, 1912, 1913] (1, B. M.).

Pandanon, near Bohol, Philippines; 55 meters [Semper, 1868; P. H. Carpenter, 1882, 1884, 1888; Perrier, 1883, 1886; Bell, 1894; A. H. Clark, 1907, 1908, 1912].

Albatross station 5355; north Balabac Strait; Balabac Light bearing S. 61° W., 16.6 miles distant (lat. 8°08′10″ N., long. 117°19′15″ E.); 80 meters; coral and sand; January 5, 1909 (1, U.S.N.M., 35979).

Albatross station 5356; north Balabac Strait; Balabac Light bearing S. 64° W., 15.5 miles distant (lat. 8°06′40″ N., long 117°18′45″ W.); 106 meters; sand and shells; January 5, 1909 [A. H. Clark, 1911, 1912, 1918] (4, U.S.N.M., 35138, 35139, 35140, 35143).

Albatross station 5141; in the vicinity of Jolo (Sulu), Philippines; Jolo Light bearing S. 17° E., 5.5 miles distant (lat. 6°09′00″ N., long. 120°58′00″ E.); 53 meters; coral sand; February 15, 1908 (1, U.S.N.M., 36033).

Dr. Th. Mortensen's Pacific Expedition 1914–1916; off Jolo; about 36 meters; lithothamnion; March 17, 1914 (1); 36–55 meters; sand and coral; March 19, 1914 (1).

Ternate (west of north central Halmahera), Moluccas [Pfeffer, 1900].

Willebrord Snellius station 60*; lat. 6°58′00″ N., long. 121°52′30″ E.; 72–80 meters [A. H. Clark, 1936] (1, L. M.).

Siboga station 257; Kei Islands, in Du-Roa Strait; down to 52 meters; coral bottom; December 11, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Siboga station 260; Kei Islands (lat. 5°36′30″ S., long. 132°55′12″ E.); 90 meters; sand, coral and shells; December 16 and 18, 1899 [A. H. Clark, 1918] (2, U.S.N.M., E. 403; Amsterdam Mus.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 26; about 90 meters; sand; April 16, 1922 (3).

Siboga station 144; anchorage north of Salomakieë (Damar) Island; 45 meters; bottom coral and lithothamnion; August 7–9, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Siboga station 305; mid-channel in Solor Strait (east of Flores); off Kampong Menanga; 113 meters; stony bottom; February 8, 1900 [A. H. Clark, 1918] (3, U.S.N.M., E. 417; Amsterdam Mus.).

Siboga station 65*a*; Kambaragi Bay, Tanah Djampeah; 400–120 meters; pale gray mud, changing to coral bottom during the haul; May 6, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Geographical range.—From the Bonin and Philippine Islands and the Macclesfield Bank to the Moluccas and the Kei and Lesser Sunda Islands.

Bathymetrical range.—From 36 to 183 meters; the average of 11 definite records is 82 meters.

History.—Among the many comatulids that he collected near Bohol in the Philippines, Prof. C. Semper found one specimen with only five arms. At first he believed it to be a young individual of some species having when fully developed 10 or more arms, but since it did not agree in its more significant characters with any other Philippine species it appeared advisable to him to describe it as a distinct form. He considered that the unique feature of the possession of only five undivided arms entitled it to recognition as a representative of a distinct genus, so he described it under the name of *Ophiocrinus indivisus*.

In the *Challenger* collection Dr. P. H. Carpenter found three species of 5-armed comatulids that he considered congeneric with Semper's *Ophiocrinus indivisus.* In a paper published in 1882, first pointing out that *Ophiocrinus* Semper, 1868, is preoccupied by *Ophiocrinus* Salter, 1853, and suggesting *Eudiocrinus* as a substitute, he redescribed the only known specimen of *Ophiocrinus* (*Eudiocrinus*) *indivisus,* which was now in the collection of Dr. W. B. Carpenter, his father, and also described the three new species from the *Challenger* collection. These last, which he called *Eudiocrinus varians, E. semperi,* and *E. japonicus,* are now referred to the genus *Pentametrocrinus.*

Carpenter in the *Challenger* reports published in 1884 and 1888 mentioned various features connected with this species but without bringing out any new information.

In 1894 Prof. F. Jeffrey Bell described and figured in detail a supposedly new species from the Macclesfield Bank, which he called *Eudiocrinus granulatus.* At that time the type specimen of Semper's *indivisus* was in the collection of W. Percy Sladen, and Professor Bell was able to compare it directly with his single specimen of *granulatus.*

In 1900 Prof. Georg Pfeffer recorded *E. indivisus* without comment from Ternate.

In 1911 I recorded and gave notes upon five specimens dredged by the *Albatross* at station 5356 in the Philippines, and in 1913 I published notes upon Bell's type specimen of *E. granulatus,* which I had examined in the British Museum in 1910. In 1918 I recorded and gave notes upon 11 specimens dredged by the *Siboga* at five stations in the Kei and Lesser Sunda Islands.

Dr. Torsten Gislén in 1922 recorded and gave notes upon a specimen from Dr. Sixten Bock's station 59 in the Bonin Islands, discussing the structure of the species, based upon a study of this specimen, at considerable length in 1924.

EUDIOCRINUS SERRIPINNA A. H. Clark

Plate 12, Figure 49

[See also vol. 1, pt. 2, fig. 267 (arm), p. 207.]

Eudiocrinus serripinna A. H. Clark, Smithsonian Misc. Coll., vol. 52, 1908, p. 211 (description; *Albatross* station 5136); Crinoids of the Indian Ocean, 1912, p. 102 (synonymy; locality); Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 65 (in key; range), p. 71 (references; notes; stations 49*a*, 310; possibly only a variety of *E. indivisus*), pp. 271, 276 (listed).

Diagnostic features.—Resembling *E. indivisus,* but the proximal pinnules are very sharply triangular in section; on the proximal pinnules, especially on P_a and P_2, the distal edges of the segments are very strongly produced at the prismatic angles dorsally, so that these pinnules have a strongly serrate dorsal profile. The arms are 40–65 mm. long, and there are 12–16 (usually 14–16) cirrus segments.

Description.—The centrodorsal is discoidal, with the rather broad dorsal pole flat. The cirri are arranged in a partially double marginal row.

The cirri are XIX, 12–16 (usually 14–15), 5–10 mm. in length. The first segment is short, the second is about as long as broad, and those following increase in

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length so that the fourth and those immediately succeeding are from about as long as the median width to half again as long as the basal width. The second-seventh or -eighth segments are centrally constricted with expanded distal ends, this expansion of the ends being especially marked dorsally so that the dorsal profile of the cirri is rather strongly serrate, but this dies away distally so that after about the tenth segment the dorsal profile becomes smooth and straight. The fifth is a more or less marked transition segment. The cirri are basally rounded in cross section, later becoming laterally compressed, the distal portion consequently appearing broader in lateral view. The opposing spine is prominent, central in position, and in height does not reach one-half the width of the penultimate segment. The terminal claw is longer than the penultimate segment and is abruptly curved basally.

The five arms are 45 to 65 mm. long. The IBr_2 and the fifth and following brachials have the distal edge produced and overlapping and scalloped, the scallops being composed of groups of fine spines, so that the proximal portion of the arms is strongly serrate in lateral view. After the proximal third of the arms these scallops merge into a uniformly finely spinous distal edge. The brachials have a narrow and distinct, though low and rounded, median carination, which is most prominent in the basal third of the arms.

The proportions of the lower pinnules are the same as in *E. individus*, but they have the distal ends on the dorsal side very strongly produced giving them a strongly serrate profile, this feature being especially marked on those pinnules that are enlarged.

Notes.—The largest specimens collected by Dr. Th. Mortensen off Jolo in about 46 meters have the arms 45–55 mm. in length; the cirri have 14–16 segments, of which the longest are only slightly longer than broad to half again as long as broad at the base. P_1 has 11 or 12 segments.

One of the specimens from the Danish Expedition to the Kei Islands station 24 has the arms 60 mm. long; the other two are smaller.

One of the specimens from the Danish Expedition to the Kei Islands station 26 has the arms about 45 mm. long. The cirri have 12 segments. The brachials have a narrow and distinct, though low and rounded, carination which is most prominent in the basal third of the arms. The IBr_2 (second postradial ossicle) and the lower brachials have produced and everted distal ends so that the basal portion of the arms is strongly serrate in lateral view. The fifth and following brachials (the seventh and following ossicles beyond the radials) have the distal edge produced and overlapping and scalloped, the scallops being composed of groups of fine spines. After the proximal third of the arms these scallops merge into a uniformly finely spinous distal edge.

The specimens from the Danish Expedition to the Kei Islands station 53 have the arms up to 65 mm. in length. Those from station 54 also have the arms up to 65 mm. long.

The specimen from *Siboga* station 310 has the cirri XIX, 14–15 (usually the latter), 10 mm. long. The first segment is short and those following gradually increase in length so that the fourth and those succeeding are about as long as the median width. In the longest cirri the fifth-eighth may be one-third again as long as the basal width. The fourth-seventh or -eighth segments are centrally constricted with expanded distal ends, this expansion of the ends being especially marked dorsally so that the dorsal profile of the cirrus is rather strongly serrate, but this dies away distally so that after the tenth segment the dorsal profile becomes smooth and straight. The fifth is a more or less marked transition segment. The five arms are 55 mm. long. P_2 is composed of 12–13 segments as in the type specimen. This individual differs from the type only in its slightly greater size.

The specimen from *Siboga* station 49*a* has the ornamentation of the brachials slightly more accentuated than in the preceding.

Parasite.—The largest individual from the Danish Expedition to the Kei Islands station 24 has a small parasitic gastropod of the genus *Melanella* (see Part 2, pages 645–649) attached to it.

Localities.—*Albatross* station 5136; in the vicinity of Jolo (Sulu); Jolo Light bearing S. 37° E., 0.7 mile distant (lat. 6°04′20″ N., long. 120°59′20″ E.); 40 meters; sand and shells; February 14, 1908 [A. H. Clark, 1908, 1912, 1915] (1, U.S.N.M., 25437).

Dr. Th. Mortensen's Pacific Expedition 1914–1916; off Jolo (Sulu); about 46 meters; sand and coral; March 19–20, 1914 (11); same, 36–55 meters; March 19, 1914 (1).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 24; 100 meters; hard bottom; April 15, 1922 (3).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 26; about 90 meters; sand; April 16, 1922 (4).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 53; 85 meters; sand and coral; May 9, 1922 (11).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 54; 85 meters; sand and coral; May 9, 1922 (10).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 57; 85 meters; sand and coral; May 9, 1922 (4).

Siboga station 310; north of the eastern end of Sumbava, Lesser Sunda Islands (lat. 8°30′ S., long. 119°07′30″ E.); 73 meters; sand with a few pieces of dead coral; February 12, 1900 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 49*a*; Sapeh Strait, between Sumbava and Komodo (lat. 8°25′30″ S., long. 119°04′36″ E.); 69 meters; coral and shells; April 14, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Geographical range.—From the Philippines to the Kei and Lesser Sunda Islands.

Bathymetrical range.—From 40 to 100 meters; the average of 10 records is 69 meters.

Remarks.—This species is known from the single specimen dredged by the *Albatross* in 1908 and described later in the same year; from two specimens dredged by the *Siboga* in 1899 and 1900 and recorded in 1918; and from 33 specimens dredged by Dr. Th. Mortensen in the Philippines in 1914 and in the Kei Islands in 1922 and herein first recorded.

EUDIOCRINUS ORNATUS A. H. Clark

Plate 11, Figure 40; Plate 12, Figure 47

[See also vol. 1, pt. 1, fig. 250 (centrodorsal), p. 253, figs. 465, 466 (centrodorsal), p. 359; pt. 2, figs. 29–31 (radial pentagon), p. 20, fig. 190 (side view), p. 111, figs. 436–439 (pinnule tips), p. 261, fig. 712 (disk), p. 346.]

Eudiocrinus ornatus A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 76 (*nomen nudum;* arms and pinnules compared with those of *E. minor*); Proc. U. S. Nat. Mus., vol. 36, 1909, p. 633 (14°04′30″ N., 93°51′00″ E.; description); Crinoids of the Indian Ocean, 1912, p. 99 (synonymy; detailed description; localities), fig. 4, p. 100; Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 65 (in key; range), p. 70 (synonymy; detailed description; Sta. 294; possibly a variety of *E. indivisus*), p. 275 (listed), pl. 17, fig. 29; Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 554 (*Investigator* station 387; notes), p. 556 (compared with *E. philenor*).

Eudiocrinus minor A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 75 (description; Andaman Islands); Crinoids of the Indian Ocean, 1912, p. 102 (synonymy; detailed description; Andaman Islands), fig. 5, p. 103; Amer. Journ. Sci., vol. 40, 1915, p. 62 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 65, footnote (synonym of *E. ornatus*).

Diagnostic features.—Resembling *E. indivisus*, but the brachials have very prominent, everted, and overlapping distal ends, giving the animal a curiously ornate appearance.

Description.—The centrodorsal is a thin disk, with the bare polar area flat, 2.5 mm. in diameter. The cirrus sockets are arranged in a single marginal row.

The cirri are XVIII, 17–18, 20 mm. long. The first segment is twice as broad as long, the second is nearly or quite as long as broad, the third–fifth are twice as long as the proximal diameter, the sixth is slightly shorter, a more or less marked transition segment, and the following gradually decrease in length so that the terminal segments are only slightly longer than broad. The penultimate segment is about as long as broad. The third–sixth segments are very strongly constricted centrally with the distal edge all around produced, except on the dorsal side; from the seventh onward both these features become less marked, and the cirrus becomes somewhat compressed laterally. There are no dorsal processes. The opposing spine is sharp, prominent, arising from the entire dorsal surface of the penultimate segment, equal to about one-half of the lateral width of that segment in height. The terminal claw is equal in length to the penultimate segment, and is stout and strongly curved.

The ends of the basal rays are visible as small tubercles in the angles of the calyx.

The distal borders of the radials project slightly beyond the rim of the centrodorsal, and are slightly concave. The IBr_1 and IBr_2 form a syzygial pair, which is oblong, from one-third to one-half again as broad as long, with the lateral edges straight, barely in apposition basally, and the ventrolateral border slightly produced.

The five arms are 85 mm. long. The first brachial is oblong, about three times as broad as long, the second is slightly wedge-shaped, about the same size, and the first syzygial pair (composed of brachials 3+4) is slightly longer on one side than on the other, half again as broad as the median length. The next three brachials are approximately oblong, two and one-half times as broad as long, and those following becoming triangular, as broad as long, and after the proximal fourth of the arm wedge-shaped, as long as broad, and in the terminal portion somewhat longer. The lower brachials have on each side, as far as the lowest pinnule, a slightly produced ventrolateral edge, corresponding with that on the IBr series. Viewed in profile the brachials have a somewhat concave dorsal surface and very prominent distal ends which are strongly overlapping and give the animal a curiously ornate appearance.

Syzygies occur between the third and fourth brachials (the fifth and sixth post-radial ossicles), again between the eighth and ninth, and distally at intervals of three, more rarely four, muscular articulations.

P_C is 5.5 mm. long, moderately stout basally, tapering evenly to the tip, rather strongly prismatic, with 12 segments, of which the first is short, the second is not quite so long as broad, the third and fourth are squarish, and the following gradually increase in length, becoming nearly or quite twice as long as broad terminally. P_1 is similar to P_C, with the same number of segments, but somewhat stouter and not tapering so rapidly. P_a is 8.5 mm. long, much stouter than P_C, gradually tapering from the base to the tip, with 12 or 15 segments, of which the first three are about as long as broad and these following very gradually become elongated and about twice as long as broad distally; the pinnule is rounded prismatic. P_2 is similar to P_a. P_b is 6 mm. long, slender, cylindrical, less stout basally than P_c, gradually tapering and becoming very delicate in the terminal portion, with 15 or 16 segments, of which the first is short, the second and third are about as long as broad, and the following gradually increase in length, becoming nearly or quite three times as long as broad in the terminal portion. P_3 is similar to P_b. The following pinnules are similar, gradually decreasing in length to 5 mm., then very slowly increasing, reaching a length of 10 mm. distally. The distal ends of the segments of the lower pinnules are more or less produced and spinous.

The disk bears a few rather large plates along the ambulacra and is well plated in the anal area.

Notes.—The preceding description is based upon specimens from *Investigator* station 61.

In the specimen from *Investigator* station 387, P_a reaches 12 mm. in length and is composed of 18 segments, of which the distal are three to four times as long as broad.

The single specimen collected by the *Investigator* and labeled Andaman Islands with no further data was described as the type specimen of a new species, *Eudiocrinus minor.* In this specimen the centrodorsal is a thin disk, with the bare flat dorsal pole 1 mm. in diameter. The cirrus sockets are arranged in a single marginal row. The cirri are XII, 12, 5 mm. long. The first two segments are twice as broad as long, the third is half again as broad as long, and the fourth is twice as long as broad. The following segments very gradually decrease in length, the antepenultimate being about one-third again as long as broad. The third and fourth segments are strongly constricted centrally, the fifth and sixth are slightly constricted, but the following have practically straight profiles. The cirri are proximally almost circular in cross section, after the fifth segment becoming laterally compressed and therefore broader in lateral view. There are no dorsal spines or projections. The opposing spine is median, small, scarcely equaling one-fourth the width of the penultimate segment in height. The arms and pinnules resemble those of *E. indivisus*, the overlapping of the brachials and pinnule segments being moderately marked. The arms are 15 mm. long. The color in alcohol is white.

One of the specimens from *Siboga* station 294 may be described as follows: The centrodorsal is discoidal, with the cirrus sockets arranged in two rows. The bare dorsal pole is 2.5 mm. in diameter. The cirri are XXI, 18, 12 mm. long, and comparatively slender. The segments increase in length to the fourth-sixth, which are about twice as long as the proximal width, and then decrease in length so that the distalmost seven or eight are about as long as broad. The longer segments are centrally constricted with widely flaring distal ends. The distal edge of the radials and the proximal border of the IBr_1 are slightly thickened and everted, and there is a slight tubercle in the middle of the latter. The distal edge of the IBr series is everted, the middle fourth being thickened into a transversely elongate tubercle. The arms are about 50 mm. long. The central half of the distal border of the proximal oblong brachials is everted and spinous, and the distal edge of the following brachials is slightly produced and finely spinous. The lateral borders of the IBr series are finely dentate. P_C is 5 mm. long and is composed of 12 segments. P_1 is 7.5 mm. long with 15 segments. P_2 is 12 mm. long with 16–18 segments, which at first are short, becoming about as long as broad on the fourth, twice as long as broad on the eighth or ninth, and slightly longer terminally. The pinnule is only moderately stout. The segments overlap slightly along the prismatic crest, where there is a slight development of spines on their distal ends. In profile the prismatic crest is slightly notched.

The other specimen from *Siboga* station 294 is similar to the one described.

The four specimens from the Danish Expedition to the Kei Islands station 26 have the arms up to 50 mm. long.

Localities.—Investigator station 61; eastnortheast of Preparis Island, between the Andamans and the delta of the Irrawadi river (lat. 14° 54′30″ N., long. 93° 51′00″ E.); 75 meters; November 30, 1889 [A. H. Clark, 1909, 1912, 1915] (6, U. S. N. M., 35133, 35135, 35136, 36244; I. M.).

Investigator station 387; off Cape Negrais, Burma (lat. 15° 25′ N., long. 93°45′ E.); 73–90 meters; sand and coral; November 16, 1909 [A. H. Clark, 1932] (1, I. M.).

Investigator; 8 miles west of Interview Island, Andamans; 493–82 meters [A. H. Clark, 1912] (2, U. S. N. M., 35144, 35163).

Investigator; Andaman Islands [A. H. Clark, 1912] (1, I. M.).

Siboga station 294; off southwestern Timor (lat. 10°12′12″ S., long. 124°27′18″ E.); 73 meters; soft mud with very fine sand; January 23, 1900 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 26; about 90 meters; sand; April 16, 1922 (4).

Geographical range.—From southwest of the delta of the Irrawadi river southward and southeastward to the Lesser Sunda and the Kei Islands.

Bathymetrical range.—According to the definite records, from 73 to 90 meters.

History.—Eudiocrinus minor was described from a single specimen taken by the Royal Indian Marine Surveying steamer *Investigator* in the Andaman Islands in a paper published on April 17, 1909. The last paragraph of the account of this new species reads: "Arms and pinnules as in *Eudiocrinus ornatus*, the overlapping of the brachials and pinnulars being moderately marked . . ." On June 19, 1909, the detailed description of *Eudiocrinus ornatus*, based upon a single specimen from *Investigator* station 61, appeared. This description had been written and submitted for publication before the description of *E. minor*, which accounts for the appearance of *Eudiocrinus ornatus*, a new name, without any explanation in the description of *E. minor*.

In 1912 both *Eudiocrinus ornatus* and *E. minor* were redescribed and figured. Of *E. ornatus* there were recorded six specimens from the type locality and one from another locality in the Andamans, while of *E. minor* the type was the only specimen mentioned.

In 1918 *Eudiocrinus minor* was placed, without explanation, in the synonym of *E. ornatus*. The name *ornatus* was used in preference to *minor* for the reason that it is based upon a fully developed individual with all its characters developed, whereas the name *minor* is based upon a small and young specimen concerning the exact determination of which it is possible to entertain a certain amount of doubt.

Technically the mention of the overlapping of the brachials and pinnulars of *E. ornatus* in the comparison with *E. minor* may be considered as an "indication" of its characters as that term is used in nomenclature, and therefore the names *minor* and *ornatus* may be regarded as of the same date.

In 1918 two specimens were recorded from *Siboga* station 294.

In 1932 I recorded and gave notes upon a specimen from *Investigator* station 387.

EUDIOCRINUS GRACILIS A. H. Clark

PLATE 12, FIGURE 48

[See also vol. 1, pt. 2, fig. 189 (side view), p. 109.]

Eudiocrinus gracilis A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 315 (description; *Investigator* station 387); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 65 (in key; range).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 7 (Burma; also represented by a somewhat divergent form [*pulchellus*] in the Bonin Islands), p. 72 (compared with *E. g.* var. *pulchellus*).—A. H. CLARK, Temminckia, vol. 1, 1936, p. 295 (listed), p. 301 (Suvadiva Atoll; notes); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 99 (range), p. 103.

Diagnostic features.—In general resembling *E. indivisus*, but P_a and P_2 are about twice as long as P_C and P_1, relatively slender, with much elongated segments of which the third is half again as long as broad and the distal are about three times as long as broad.

Description.—The centrodorsal resembles that of *E. indivisus*.

The cirri are X, 15–16, 9 mm. long. The first segment is about three times as broad as long, the second is about twice as broad as long, the third is about as long as the width of its expanded distal end, and the fourth and fifth are about twice as long as their proximal width, the fifth being slightly longer than the fourth. The following segments are about as long as their distal width. The cirri taper gradually to the fifth segment, which is a well marked transition segment, and are more delicate from that point onward. The longer earlier segments are strongly constricted centrally with prominent flaring distal ends. Beyond the fifth segment the ventral profile becomes straight, but the distal dorsal edge is produced so that the dorsal profile of the cirrus as a whole is strongly serrate. The antepenultimate segment is slightly longer than broad, without any production of the distal dorsal edge. The penultimate segment is wedge-shaped, about as long as the greater (ventral) length. The opposing spine is prominent, arising from the entire dorsal surface of the penultimate segment, with the apex terminal, and is equal in height to about one-half the width of the segment. The terminal claw is about as long as the penultimate segment and is rather stout; it is strongly curved proximally, but becomes more slender and straighter distally.

The arms are essentially like those of *E. indivisus* and measure 55 mm. in length.

P_C is 3.5 mm. long with 9 or 10 segments. It is small and weak, rounded-prismatic, and tapers evenly from the base to the tip. The segments are at first short, becoming about as long as broad on the third and twice as long as broad, or even longer, terminally. P_1 is 4.5 mm. long with 9 or 10 segments, resembling P_C but proportionally larger and stouter. P_a is 7 mm. long, much larger and stouter than the preceding or succeeding pinnules, with 10 segments of which the first is slightly over twice as broad as long, the second is about half again as broad as long, and the third is half again as long as broad; the following segments gradually increase in length and become about 3 times as long as broad distally. The pinnule is much more slender than the corresponding pinnule in the other species of the genus. The second and following segments have rather strongly produced distal edges which are armed with fine spines. P_2 is similar but slightly longer and larger. P_b is 5 mm. long, slender, with 12 segments, in general resembling the preceding pinnules. P_c is 3 mm. long with 9 or 10 segments which after the third become much elongated, small, and weak. The distal pinnules are very slender, 6 mm. long.

The color in alcohol is a uniform dark purple, the cirri beyond the transition segment being nearly white.

Notes.—The second specimen from the type locality has the cirri XIII, 16–18 (usually 18), 10 to 12 mm. long; the sixth is a transition segment. P_C is 4 mm. long, with 10 segments. P_a is 9 mm. long, with 11 segments. P_b is 6.5 mm. long, with 14 segments.

The individual from the Kei Islands is apparently of this species, although the identification is not quite positive.

In the larger specimen from the Maldive Archipelago the cirri are XVI, 13–16. The first segment is very short, the second is somewhat more than twice as broad as long, the third is nearly twice as long as the median width, the fourth is about twice as long as the width of the proximal end, the fifth is not quite so long, and those following slowly decrease in length to the tenth or eleventh, which is half again as long as the width of the proximal end, then increase in length slightly so that the antepenultimate is from half again to twice as long as broad. The second-seventh segments are rather strongly constricted centrally, this feature decreasing distally so that the last two or three segments before the penultimate are oblong. The opposing spine is small, sharp, erect, and subterminal. The terminal claw is about as long as the penultimate segment, and is stout, rapidly tapering, and moderately curved. P_C is 2.5 to 3 mm. long with 9 segments. It is stout basally, rapidly tapering to a fine tip, and is strongly prismatic. The first segment is short, the second is twice as broad as long, the third varies from nearly as long as broad to one-third again as broad as long, the fourth is from one-third to one-half again as long as broad, and those following are about twice as long as broad, becoming longer distally. The first three or four segments are rather strongly carinate, the crest of the carination being parallel with the axis of the pinnule. P_1 is 3.5 mm. long with 10 segments, similar to P_C but larger. The second-fourth segments are strongly carinate, and the fifth is slightly so. P_a is 5 mm. long with 11 segments, somewhat broader basally than P_C, tapering evenly from the base to a slender and delicate tip, slender and rather flexible. The first segment is about twice as broad as long, the second is slightly broader than long, the third is half again as long as broad, the fourth is twice as long as broad, the fifth is nearly or quite three times as long as broad, and those following are still longer, the distal about six times as long as broad and very slender. The pinnule is slightly, though distinctly, carinate, and the first three segments have slight dorsal processes on the side toward the arm tips. The ends of the segments are very slightly and finely spinous, the spines being longest at the prismatic angles. P_2 is 5 mm. long and resembles P_a. Syzgyies occur between the elements of the IBr series, and between brachials 3+4, 8+9, 13+14, and 17+18, and distally at intervals of 3 muscular articulations.

Localities.—*Investigator* station 387; off Cape Negrais, Burma (lat. 15° 25′ N., long. 93° 45′ E.); 73–89 meters; sand and coral; November 16, 1909 [A. H. Clark, 1912] (2, U. S. N. M., 35141; I. M.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 54; 85 meters; sand and coral; May 9, 1922 (1, C. M.).

Suvadiva atoll, Maldive Archipelago; lagoon; 80 meters or less; *Willebrord Snellius,* May 4, 1929 [A. H. Clark, 1936] (2, L. M.).

Remarks.—This species is as yet known only from the two specimens dredged by the Royal Indian Marine Surveying steamer *Investigator* in 1909 and described in 1912, another from the Kei Islands collected by Dr. Th. Mortensen and not previously recorded, and two from the Maldive Islands dredged by the *Willebrord Snellius* in 1929.

EUDIOCRINUS PULCHELLUS Gislén

Eudiocrinus gracilis var. *pulchellus* Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 4 (127–182 m.), p. 69 (Bock's stations 45, 46, 47, 48, 53; description and discussion).

Eudiocrinus gracilis pulchellus Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 6 (Bonin Islands), pp. 8, 73, 182, 183 (listed), figs. 60–63, p. 70, pl. 1, fig. 5 —Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 17.

Eudiocriuus gracilis pulchellus Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 182 (listed).

Diagnostic features.—This species is closely related to *E. gracilis* and possesses similar long-segmented P_a and P_2; but these pinnules are scarcely longer than the other proximal pinnules instead of being markedly longer as is the case in *E. gracilis.*

Description.—According to Gislén the centrodorsal is flattened, 1.5 mm. in diameter, with the free dorsal pole 1 mm. in diameter.

The cirri are XIX, 13–15, from 5.5 to 6.5 mm. in length. The first two segments are broader than long, the third is as long as broad, and the fourth-sixth are about twice as long as the median width. The following segments become shorter again, the antepenultimate being about as long as broad.

The radials are smooth. The IBr series is as long as broad.

The five arms are 40 mm. in length. The brachials do not overlap, even in the distal portion of the arms. The width of the first brachial is 0.8 mm.

Syzygies occur between brachials 3+4, 9+10, and 13+14, and distally at intervals of 3 muscular articulations.

P_C is 2.5 mm. long, with 10 segments. P_1 is 3 mm. long, with 10 segments. P_a is 4 mm. long, with 10 segments. P_2 is 4 mm. long, with 12 segments. The second segment of P_a and P_2 is not quite so long as broad, the third segment is one-third to one-half again as long as broad, and the distal segments are three times as long as broad, somewhat expanded at the distal end but only slightly spiny. P_b is 3.5 mm. long, with 11 segments. P_3 is 3.5 mm. long, with 12 segments. The distal pinnules are 5.5 mm. long with 15 or 16 segments, which are three to four times as long as broad, and of which the outermost bear dorsal hooks. There are three pairs of large sacculi on each segment.

The disk has been lost; it was about 2 mm. in diameter.

The proximal muscular articulations are dark colored. From about the seventh the brachials are wedge-shaped, each with a pair of dark longitudinal bands.

Notes.—The specimen described was from station 46. Another specimen from the same station showed the following characters: The cirri are XVII, 10–14, from 4.5 to 6.5 mm. long. The arms are 30 mm. long. P_C is 2 mm. long, with 8 segments. P_1 is 2 mm. long, with 8 segments. P_a is 3.5 mm. long, with 10 segments. P_2 is 3.2 mm. long, with 10 segments. P_b has 12 segments. The distal pinnules are 5 mm. long, with 14 segments. The third segments of P_1 and P_a are one-third again as long as broad. The disk is 1.5 mm. in diameter, and the anal tube is 0.8 mm. high.

In a specimen from Bock's station 47 the cirri are XVI, 13–16, from 6.5 to 8 mm. long. The fifth segment is twice as long as broad and is centrally constricted. The arms are 40 mm. long. P_C is 2.5 mm. long, with 8 segments. P_1 has 8 segments. The third segments of P_1 and P_a are one-third again as long as broad. P_2 is 5 mm. long with 13 segments. P_c is 4.5 mm. long, with 12 or 13 segments. The distal pinnules are 7 mm. long, with 18 segments, which are three to three and one-half times as long as broad. The disk is 2 mm. in diameter.

In another specimen from station 47 the cirri are XVI, 12–15, from 5 to 6 mm. long. The cirrus segments are a little shorter than in the preceding specimen, one-half to three-quarters again as long as broad. The arms are 35 mm. long. P_C is 2 mm. long, with 7 segments. P_1 has 8 segments. P_a is 4.2 mm. long, with 13 segments, of which the third is half again as long as broad. P_2 has 12 segments. P_b is 4 mm. long, with 12 segments. The disk is 1.8 mm. in diameter.

In a specimen from station 48 the cirri are XIV, 14–16, from 6 to 7 mm. long. The arms are 30 mm. long. P_C is 2 mm. long, with 8 segments. P_1 is 2.2 mm. long, with 9 segments. P_a is 3.7 mm. long, with 13 segments, of which the third is one-fourth again as long as broad. P_b is 3.5 mm. long, with 11 segments. The distal pinnules are 4.5 mm. long, with 14 segments, which are twice as long as broad.

In a small specimen from station 53 the cirri are XV, 8–12, from 2 to 4 mm. long. The arms are 10+ mm. long. There are strong prominences on the proximal ossicles as in the smallest specimen from station 45. P_C is 1.2 mm. long, with 6 segments. P_1 is 1.2 mm. long, with 7 segments. P_a has 7 segments, of which the third is one-half to three-quarters again as long as broad.

In a specimen from station 45 the cirri are XV, 14–15, from 5 to 6.5 mm. long. The arms are 40 mm. long. P_C is 2.2 mm. long, with 8 segments. P_1 is 2.7 mm. long, with 9 segments. P_a is 4.5 mm. long, with 10 segments. P_2 is 4.5 to 5 mm. long, with 11 segments. The distal pinnules are 6.2 mm. long, with 18 segments, which are three times as long as broad. The disk is 2 mm. in diameter.

In another specimen from station 45 the centrodorsal is 1 mm. in diameter with the free dorsal pole 0.5 mm. in diameter. The cirri are XIX, 13–15, from 4 to 6.5 mm. long. The arms are 35 mm. long. P_C is 2 mm. long, with 7 or 8 segments. P_1 is 2.5 mm. long, with 9 segments. P_a is 3.5 mm. long, with 11 segments. The third segment of P_1 and P_a is one-third again as long as broad. P_b has 12 segments. The distal pinnules are 6 mm. long, with 18 segments. The disk is 2 mm. in diameter.

In a third specimen from station 45 the cirri are XVIII, 12–13, from 3.5 to 5 mm. long. The arms are 25 mm. long. P_c is 2.2 mm. long, with 9 segments. P_1 is 2.4 mm. long, with 9 segments. P_a is 3.3 mm. long, with 10 segments. P_2 is 3 mm. long, with 10 segments. P_b is 3.2 mm. long, with 12 segments. P_3 is 3.2 mm. long, with 13 segments. The disk is 2 mm. in diameter.

In a fourth specimen from station 45 the cirri are about XX, 13–14, from 4 to 5 mm. long. The arms are 23 mm. long. The proximal border of the IBr_1 is very slightly everted. P_C is 1.8 mm. long, with 6 or 7 segments. P_1 is 2.2 mm. long, with 8 segments. P_a is 3.2 mm. long, with 9 segments. P_2 is 2.7 mm. long, with 9 segments. P_b is 3 mm. long, with 10 segments. P_3 is 3.5 mm. long, with 11 segments. P_2 and P_3 have rather serrate distal segments. The disk is 2 mm. in diameter. This specimen, according to Gislén, is transitional between the larger specimens and the very small ones from stations 45 and 53.

In a small specimen from station 45 the cirri are XX, 11–12, from 2.5 to 3 mm. long. The length of the third segment is one-fourth more than the width of the expanded distal end. The fourth segment is twice as long as the distal width and is strongly constricted centrally. The fifth and sixth segments are proximally a little narrower. The segments from the seventh to the antepenultimate are half again as long as broad and are laterally compressed. The opposing spine is sharp, its length equaling about half the width of the penultimate segment. The terminal claw is pointed, curved, and somewhat longer than the penultimate segment. The five arms are about 20 mm. long. The radials are visible as a narrow band with a median prominence; they are separated at the interradial angles by the basals. The IBr_1 are proximally everted with a median keel which in height, as viewed laterally, equals one-third the thickness of the ossicle. There is a similar prominence on the distal part of the IBr_2 and the first two brachials where laterally, however, it has no distinct border. The ends of the segments are slightly everted. The brachials from the eighth onward have oblique ends. Syzygies occur between brachials 3+4 and 13+14, and distally at intervals of three (or four) muscular articulations. P_C is 1.5 mm. long with 6 segments. P_1 has 6 segments of which the second-fourth are half again as long as broad. P_a is 2 mm. long with 8 segments of which the third-fifth are twice as long as broad. The distal ends of the pinnule segments are spiny and are somewhat everted. The segments of the distal pinnules are very long, four or five times as long as broad. The disk is 1 mm. in diameter. The anal tube is smooth and subcentral. The mouth is subcentral. The sacculi are dark. The color in alocohol is yellowish white.

The small specimens from stations 45 and 53 are, according to Gislén, evidently young individuals of this form although of an ornate type.

Localities.—Dr. Sixten Bock's Expedition to Japan station 46; Bonin Islands, east of the Channel; 128 meters; August 1, 1914 [Gislén, 1922].

Dr. Sixten Bock's Expedition to Japan station 47; Bonin Islands; east of the Channel; 146 meters; August 1, 1914 [Gislén, 1922].

Dr. Sixten Bock's Expedition to Japan station 48; Bonin Islands; east of Chichijima; 183 meters; August 1, 1914 [Gislén, 1922].

Dr. Sixten Bock's Expedition to Japan station 53; Bonin Islands, 2 miles east of Higashijima; 164 meters; sand and broken shells; August 8, 1914 [Gislén, 1922].

Dr. Sixten Bock's Expedition to Japan station 45; Bonin Islands, east of Chichijima; 146 meters; July 31, 1914 [Gislén, 1922].

Geographical range.—Known only from the Bonin Islands.

Bathymetrical range.—Apparently from 128 to 183 meters; but the depths as given represent the length of dredging wire out, not the actual depths.

Remarks.—This species is known only from the 11 specimens collected by Dr. Sixten Bock in 1914 and described by Dr. Torsten Gislén in 1922.

EUDIOCRINUS sp.

Eudiocrinus sp. A. H. Clark, Temminckia, vol. 1, 1936, p. 302.

Locality.—Binonko, Toekay Besi Island; about 10 meters; *Willebrord Snellius*, March 7–10, 1930.

Remarks.—A small undeterminable individual was dredged at this locality.

Family HIMEROMETRIDAE A. H. Clark

Savignyii group P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, No. 95, 1882, p. 508.

Basicurva group (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 102 (*Antedon denticulata* only).—Hartlaub, Bull. Mus. Comp. Zool., vol. 27, 1895, p. 130.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1907, pp. 127, 128; Smithsonian Misc. Coll., vol. 50, 1907, pp. 343–345, 348, 359, 361; Proc. U. S. Nat. Mus., vol. 36, 1909, p. 365.

Milberti group (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 192 (*Antedon pinniformis, A. milberti, A. laevissima* [part], *A. tessellata, A. anceps*, and *A. variipinna*).—P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 304 (species collected at Mergui).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, pp. 13, 80; Bull. Mus. Comp. Zool., vol. 27, p. 137 (structural position).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, pp. 343, 344 (characters differentiating this group not diagnostic), p. 345 (heterogeneous character of the group), p. 349 (*Tropiometra*, gen. nov., includes part of the species), p. 357 (*Cyllometra*, gen. nov., includes part of the species).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 370.

Palmata group (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 223 (*Antedon clemens*). (For further references to this group see page 391.)

Savignyi group P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 252 (all the included species except *Antedon angustiradia*).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 13 (diagnosis; range; 16 species), p. 15 (diagnosis; discussion), p. 16 (key to the species included); Bull. Mus. Comp. Zool., vol. 27, 1895, p. 137 (structural position).

Savignii group A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 343 (characters differentiating this group not diagnostic), p. 355 (*Himerometra*, gen. nov., includes part of species), p. 364 (one species [*angustiradia*] referred to *Adelometra*, gen. nov.).

Himerometridae A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 126 (covering *Oligometra*, gen. nov.), p. 135 (including *Himerometra*, *Pontiometra*, *Cyllometra*, and *Oligometra*); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 210 (in key), p. 211 (includes *Oligometra*, *Cyllometra*, *Himerometra*, and *Pontiometra;* range; not represented in the Hawaiian Islands), p. 212 (range of included genera); vol. 35, p. 119 (footnote), fig. 20, p. 120 (arm structure); Amer. Nat., vol. 42, 1908, p. 541 (characteristic of the Indo-Pacific-Japanese faunal area), p. 725 (color); Geogr. Journ., vol. 32, 1908, p. 602 (characteristic of the Indo-Pacific-Japanese faunal area), p. 605 (ecology); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 1 (revision; description of new genera); Amer. Nat., vol. 43, 1909, p. 254 (represented in the Red Sea); Proc. U. S. Nat. Mus., vol. 36, 1909, p. 361 (part of *Antedon* as understood by P. H. Carpenter), p. 365 (mouth often more or less eccentric in certain species); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 144 (*Mariametra*, gen. nov., described in this family), p. 174 (referred to the Comatulida Oligophreata), p. 175 (divided into three subfamilies, Himerometrinae, Stephanometrinae, and Mariametrinae, and *Pontiometra* removed to a separate family, Pontiometridae); Vid. Medd. Nat. Foren. København, 1909, p. 119 (occurs at Singapore; has large eggs that presumably develop rapidly; ecology), p. 148 (arm tips in *Comatula pectinata* normally as in species of this family), p. 152 (cirri compared with those of *Zygometra fluctuans* [=*comata*]); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 6 (12 species in Africa), p. 8 (species on southeast coast), p. 9 (species on northeast coast), p. 10 (West Indian and corresponding East Indian genera), p. 649 (referred to the Oligophreata); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 438 (3 genera and 7 species in Australia); Mem. Australian Mus., vol. 4, 1911, p. 717 (proportion of species of this family in Australia as known to P. H. Carpenter), p. 720 (proportion of species in Australian fauna), p. 725 (*Himerometra* absent from Australia), p. 728 (3 subfamilies, Himerometrinae, Mariametrinae, and Stephanometrinae, raised to family rank), p. 730 (in key), p. 731 (key to Australian genera).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 371.—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 6 (family exclusively confined to East Indian region; number of included genera and species), p. 11 (represented in the Ceylon region by *Amphimetra*, *Himerometra*, and *Heterometra*), p. 12 (represented in Red Sea region by *Craspedometra* and *Heterometra;* represented in southeast African region by *Amphimetra*, *Craspedometra*, and *Heterometra*), p. 21 (range in detail; exclusively littoral, not extending deeper than 50 fathoms), p. 42 (family discarded, the 3 included subfamilies raised to family rank), pp. 46, 49, 53 (in keys), p. 56 (key to included genera); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 311 (discussion, and comparison with Zygometridae); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7, 8 (relation to temperature); Journ. Washington Acad. Sci., vol. 4, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges), p. 582 (relation to temperature of habitat).—Alexander, Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 108.—A. H. Clark, Rec. Western Australian Mus. vol. 1, pt. 3, 1914, p. 114 (species collected by *Endeavour* in Western Australia); Amer. Journ. Sci., vol. 40, 1915, p. 67 (detailed philosophical discussion of bathymetrical range); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1915, p. 223 ff. (detailed account of distribution of Australian species); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, p. 45 ff. (phylogenetical study); Unstalked crinoids of the *Siboga* Exped., 1918, p. 72 (key to the included genera).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 23.—A. H. Clark, Univ. Iowa Stud. Nat. Hist., vol. 9, No. 5, 1921, p. 14 (not represented in West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 3.—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 19, 35, 42, 55, 77, 84, 89, 99, 118, 230, 231, 235, 240, 280, 287; Arkiv for Zool., vol. 19, No. 32, 1928, p. 4.—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 638; Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 556; Treubia, vol. 14, livr. 2, 1933, pp. 207, 211.— Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 8, 18, 22, 23, 27, 28, 43, 44, 45, 46, 47, 48, 49, 53.—A. H. Clark, Temminckia, vol. 1, 1936, p. 302.—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 8.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, pp. 99, 103.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, pp. 4, 10.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 33.—Boone, Bull. Vanderbilt Marine Mus., vol. 7, 1938, p. 122.

Himerometrinae A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 175 (includes *Amphimetra, Himerometra, Craspedometra,* and *Heterometra*); Mem. Australian Mus., vol. 4, 1911, p. 728 (raised to family rank), p. 730 (in key, through inadvertence); Journ. Washington Acad. Sci., vol. 5, 1915, pp. 126–134 (bathymetrical range; phylogenetical and palaeontological significance).

Himeromètres A. H. Clark, Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 250.

Himorometridae A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 728 (typographical error).

Diagnosis.—A family of the superfamily Mariametrida in which the elements of the IBr series are united by synarthry and the arms are 10 or more in number; if there are more than 10 arms the IIBr series are typically 4(3+4), though in any individual some of these may be replaced by IIBr series of two elements; the brachials are always short and are frequently—always in the 10-armed species—exceedingly short with almost or quite parallel ends. The persiome of the disk is usually naked, rarely bearing small scattered concretions, which are especially evident in the anal area (see Part 2, p. 228). The lateral perisome of the pinnules usually contains simple, forked, or multiradiate spicules, very rarely delicate filmy plates of from 2 to 15 meshes, between which and the edge of the pinnulars are small straight or rarely forked spicules or small rods; but calcareous deposits are frequently wholly absent (see Part 2, pp. 239–241).

Geographical range.—From southern Japan southward to the Philippines, Tonga and Fiji, Port Molle, Queensland, and to between Fremantle and Geraldton, Western Australia, and westward to east Africa, from the Red Sea southward to Zanzibar and Bagamoyo.

Bathymetrical range.—From the intertidal zone down to 111 (?183) meters.

Remarks.—The 41 forms included in the family Himerometridae fall into five genera—*Himerometra, Craspedometra, Homalometra, Heterometra,* and *Amphimetra. Amphimetra* is rather sharply differentiated from the other four, which together form a closely knit unit.

The six species of *Himerometra* are easily distinguished by their narrow and well-separated division series combined with the very short brachials and the much enlarged proximal pinnules, which decrease in size from the lowest outward. But in *Himerometra bartschi* and in *H. persica* the proximal pinnules are no stouter than they are in many species of *Heterometra* and, as in the latter, have the lower segments strongly carinate, while the lowest is sometimes shorter than the next. Also in *Heterometra variipinna* P_2, though by no means greatly enlarged, is of quite the same type as the enlarged proximal pinnules in *Himerometra magnipinna* and in *H. sol.* Thus *Himerometra* shows a very close approach to two apparently different genetic lines within the genus *Heterometra,* although the two genera seem not actually to intergrade.

An interesting feature of the species of *Himerometra* is that typically the two outer IIIBr series on each ray are 4(3+4) and the two inner are 2, though this arrangement is by no means invariable. This distribution of IIIBr series of 4(3+4) and of 2 is not confined to *Himerometra,* for it occurs also in *Craspedometra* and is frequently more or less strongly evident in the large species of *Zygometra* (*microdiscus* and *elegans*) and in *Heterometra philiberti.*

Although when typically developed its appearance is very distinctive, the single species of *Craspedometra* is very closely allied with certain species of *Heterometra.*

Indeed, it is probably more closely allied with them than they are with other species included within the same genus. But there is a more definite break between *Craspedometra* and *Heterometra* than occurs anywhere within the species groups included in the latter genus.

The single species of *Homalometra*, like that of *Craspedometra*, is merely an offshoot from one of the several genetic lines included in the genus *Heterometra;* but there is a considerable gap between *Homalometra* and the most closely related species of *Heterometra.*

The eight species and forms included in the genus *Amphimetra* form a closely knit unit that is rather abruptly distinct from the other types included in the family Himerometridae. Though in its arm structure, particularly in the very short brachials, *Amphimetra* closely approaches one of the groups within the genus *Heterometra,* and also the genus *Himerometra,* it shows certain features which indicate an approach to the Colobometridae. Thus through individual variation specimens of *Amphimetra tessellata tessellata* develop IIBr series, which are always of 2 elements and not 4(3+4) as in the other genera of Himerometridae, and other specimens have the dorsal processes on the cirrus segments much broadened and somestimes forked.

Like the species of the Zygometridae, the species of Himerometridae are especially characteristic of the region from southern Japan to northern Australia and the eastern portion of the Bay of Bengal. One genus (*Amphimetra*) extends westward to the Maldive archipelago, one (*Himerometra*) is represented by a single species in the Persian Gulf, and a third (*Heterometra*) is represented by several species on the east African coast.

All the genera but one (*Homalometra*) are represented at the low-tide mark, and the included species are chiefly to be found in very shallow water. None of the species have been dredged from a greater depth than 111 (or possibly 183) meters.

History.—The family Himerometridae was first mentioned in my paper on new genera of unstalked crinoids published on April 11, 1908, as a simple heading under which the new genus *Oligometra* was described. Later in the same paper the genera of free crinoids belonging to the Comatulida were grouped in several families, which were not defined. Among these was the family Himerometridae, including the genera *Himerometra, Pontiometra, Cyllometra,* and *Oligometra.*

In a paper of mine published on May 14, 1908, a key to the families of Comatulida having recent representatives was given, in which the family Himerometridae was included. The family Himerometridae was said to contain the genera *Oligometra, Cyllometra, Himerometra,* and *Pontiometra,* and its range was given.

In my paper published on October 30, 1908, the arm structure and brachial homologies of the family Himerometridae were discussed in detail.

In a revision of the family Himerometridae published on January 9, 1909, the following new genera, including species previously assigned to the large and heterogeneous genus *Himerometra,* were added to it — *Colobometra, Amphimetra, Cenometra, Craspedometra, Stephanometra, Heterometra,* and *Dichrometra*—and the new genus *Oxymetra* was mentioned but not defined.

In a paper on the new genus *Comatilia* published on April 27, 1909, I remarked that I had become convinced that the division of the recent comatulids into two contrasted groups, called by Carpenter *Antedon* and *Actinometra,* was very artificial and could not stand the test of modern systematic methods. Instead of these two genera I therefore proposed to recognize five great divisions, the families Comasteridae, Zygometridae Himerometridae, Tropiometridae, and Thalassometridae, which covered exactly the same ground except that the number of included species was nearly, if not quite, doubled. I remarked that each of these families appeared to me to be separated from the others by characters of just as great importance as those separating the Comasteridae (the old genus *Actinometra*) from any one of them. In the same paper I noted that in the species of Himerometridae the mouth is often more or less eccentric.

In a paper on new recent Indian crinoids published on June 25, 1909, I used the family name Colobometridae as a heading under which two new species of *Cenometra* (*herdmani* and *insueta*) and one of *Cyllometra* (*soluta*) were described, thus restricting the family Himerometridae by the removal of *Cenometra*, *Cyllometra*, and *Colobometra*, and also *Oligometra*, although the last was not mentioned.

In a paper published on September 14, 1909, I still further restricted the family Himerometridae by removing the genus *Pontiometra* to the new family Pontiometridae. At the same time I divided the family Himerometridae into three subfamilies, Himerometrinae, including the genera *Amphimetra*, *Himerometra*, *Craspedometra*, and *Heterometra;* Stephanometrinae, including the genus *Stephanometra;* and Mariametrinae, including the genera *Mariametra* and *Dichrometra*.

In a paper on the recent crinoids of Australia published on August 17, 1911, I said that recent discoveries have shown that the Zygometridae are not nearly so sharply differentiated from the Himerometridae as was previously supposed, and it has therefore seemed best to discard the latter family altogether, raising the three subfamilies previously included within it to family rank. The three families into which the Himerometridae are divided are the Himerometridae, Stephanometridae, and Mariametridae.

Since that time the family Himerometridae has remained unchanged.

The group now known as the family Himerometridae was somewhat indefinitely indicated by Dr. P. H. Carpenter in 1882 as the *Savignyii* group of *Antedon*. In Carpenter's report on the *Challenger* comatulids published in 1888 the *Savignyi* group is essentially the equivalent of the family Himerometridae, except for the inclusion of *Antedon* (*Adelometra*) *angustiradia*. But the 10-armed species, and 10-armed individuals of multibrachiate species, are included in the *Milberti* group. Thus the species of *Amphimetra* are assigned to the *Milberti* group, and *Antedon anceps* (= *Heterometra quinduplicava*) and *Antedon variipinna* (= *Heterometra crenulata*) occur both in the *Milberti* and in the *Savignyi* groups. One species, *Antedon* (*Homalometra*) *denticulata* was placed by Carpenter in the *Basicurva* group, and another, *Antedon clemens* (= *Heterometra quinduplicava*), in the *Palmata* group.

KEY TO THE GENERA OF THE FAMILY HIMEROMETRIDAE

a^1. P_D and P_1 longer and stouter than P_2, which in turn is longer and stouter than P_3; division series strongly rounded dorsally and well separated; usually more than 25 arms; the IIIBr series are usually 4(3+4) on the outer side of each IIBr series and 2 on the inner side (Philippine Islands and Macclesfield Bank southward to Admiralty Islands, Great Barrier Reef, and Kei Islands, and westward to Maldive Archipelago and Persian Gulf; 0–57 [?66] meters)........ **Himerometra** (p. 185)

a^2. P_1 (and P_D when present) shorter and more slender than P_2.

- b^1. Cirri gradually tapering to a sharp point distally, the distal cirrus segments proportionately as long as, or longer than, the proximal, twice as long as broad or even longer, and entirely without dorsal processes; no opposing spine; terminal claw long and nearly straight; outer portion of cirri very slightly, sometimes not at all, recurved.
  - c^1. Cirri very long and stout, one-third to almost half as long as the arms, with 40–60 (usually 45–50) segments; proximal portion of the cirri light in color, each segment with a ventral purple saddle, the distal portion brown; division series usually broad, well rounded dorsally, not in lateral contact; large and robust with 20–36 arms 90–130 mm. long (Philippines and Hongkong southward to Amboina and westward to Andaman Islands and Gulf of Martaban; 0–33 meters)------------------------------------**Craspedometra** (p. 214)
  - c^2. Cirri small and very slender, less than one-third the arm length, with 25–30 segments, and entirely white; slender species with 10 or 11 arms 70–90 mm. long (Arafura Sea to western end of New Guinea; 90–95 meters)----------------------------**Homalometra** (p. 337)
- b^2. Distal cirrus segments always with dorsal tubercles or spines, and the terminal claw always strongly curved; distal cirrus segments usually shorter than the proximal, or both distal and proximal cirrus segments broader than long.
  - c^1. More than 10 arms; enlarged lower pinnules much elongated, plain, or with the lower segments carinate, or the outer segments bearing flange-like processes or having very spinous distal ends; in some species 10-armed individuals occur; these are easily distinguished by the strongly carinate or otherwise modified proximal pinnules (southern Japan southward to Port Curtis, Queensland, and Baudin Island, northwestern Australia, and westward to Madagascar and east coast of Africa from Red Sea to Zanzibar and Bagamoyo; 0–111 meters)--**Heterometra** (p. 225)
  - c^2. Arms 10; enlarged lower pinnules but slightly differentiated from those following, not much enlarged and but little elongated; occasional individuals may have more than 10 arms; in these the IIBr series are 2 instead of 4(3+4) (southern Japan southward to the Philippines, Fiji, and Tonga, Port Molle, Queensland, and to between Fremantle and Geraldton, Western Australia, and westward to Maldive Archipelago; 0–109 [?183] meters)--------**Amphimetra** (p. 340)

Genus HIMEROMETRA A. H. Clark

Actinometra (part) P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 201.

Antedon (part) Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 182, and following authors.

Himerometra A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 350 (variation in the component species), p. 355 (diagnosis; genotype *Antedon crassipinna* Hartlaub, 1890); Bull. Mus. Comp. Zool., vol. 51, 1908, p. 247 (characters; genotype *Antedon crassipinna* Hartlaub, 1890); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (referred to Himerometridae); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 211 (referred to Himerometridae), p. 212 (occurs in Japan [error]), pp. 308, 317; vol. 35, 1908, fig. 20, p. 120 (arm structure); Amer. Nat., vol. 42, 1908, p. 722 (ecology); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 1 (revision), p. 7 (included species, as restricted); Amer. Nat., vol. 43, 1909, p. 256 (absence from Red Sea); Zool. Anz., vol. 34, 1909, p. 367 (arm division similar to that of *Zygometra elegans*); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 175 (referred to Himerometrinae); Vid. Medd. Nat. Foren. København, 1909, p. 152 (brachials compared with those of *Zygometra fluctuans* [*comata*]), p. 160 (brachials compared with those of *Craspedometra acuticirra*); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 455 (a specimen of *Comanthina belli* recorded with the arm division characteristic of this genus); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); Crinoids of the Indian Ocean, 1912, p. 9 (absent from Australia), p. 10 (absent from Japan; reason), p. 11 (represented in Ceylon region; this the western limit of the large and highly multibrachiate species), p. 12 (occurs in Persian Gulf but not in Red Sea), p. 21 (range in detail), p. 56 (in key), p. 114 (original reference; genotype).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, pp. 370, 371 (discussion).—A. H. Clark, Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 311 (comparison with the large species of Zygometridae); Proc. U. S. Nat. Mus., vol. 46, 1913, pp. 279–289 (detailed account, with revision of the included species); Unstalked crinoids of the

Siboga-Exped., 1918, p. 72 (in key; range), p. 73 (key to the included species).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 35 (brachial homologies), p. 51 (obliquity of brachials), pp. 92, 99 (pinnule articulations).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 40, 45, 46, 48, 52, 53, 54, 57.

Heterometra (part) A. H. Clark, Vid. Medd. Nat. Foren. København, 1909, pp. 164, 165, 193; Crinoids of the Indian Ocean, 1912, p. 127.

Craspedometra (part) Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnosis.—A genus of Himerometridae in which P_D is much longer and stouter than P_1, which in turn is much longer and stouter than P_2; the division series are narrow, strongly rounded dorsally, and widely separated laterally; the IIIBr series on the outer side of each IIBr series are 4(3+4), but on the inner side usually 2; the brachials are exceedingly short, discoidal, with produced and overlapping distal ends. The species are large and robust with 20–62 (but seldom less than 30) arms, which are 100 to 200 (commonly 130–150) mm. in length.

Geographical range.—From the Philippine Islands and the Macclesfield Bank south to the Admiralty Islands, the Moluccas, the Kei Islands, and the Great Barrier reef, Queensland, and westward to the Maldive Islands and the Persian Gulf.

Bathymetrical range.—From the shoreline down to 57 (?66) meters; chiefly littoral and sublittoral.

Remarks.—The species of the genus *Himerometra* are very easily distinguished from all the other forms in the family Himerometridae by the fact that P_D is the longest and largest pinnule, the pinnules succeeding gradually decreasing in size to P_3. In addition to the characteristic pinnule structure, the strongly rounded, narrow, and well-separated division series and exceedingly short discoidal brachials are features that aid in the prompt generic determination of the included forms.

The six species of the genus recognized herein are divisible into three groups of two each.

The first group, including *H. bartschi* and *H. persica*, is rather sharply separated from the others. The slender proximal pinnules of these two species, which have carinate basal segments, resemble in structure the corresponding pinnules in certain species of *Heterometra* very closely—much more closely than they do the pinnules of the other species of *Himerometra*—and it is interesting to note that although P_D is almost invariably longer than P_P and P_P is longer than P_1, in a specimen of *H. bartschi* from the Kei Islands (see page 211) P_P is slightly longer and usually somewhat stouter than Pp. In these two species also the pinnules following the enlarged proximal pinnules have the basal segments strongly carinate, a feature common in the species of *Heterometra* but not found in the other species of *Himerometra*. Another peculiarity of these two forms is that their outer cirrus segments bear more or less prominent spines instead of being smooth or bearing obsolescent tubercles. While these two species can only be regarded as belonging to the genus *Himerometra*, with the other species of which they agree completely in the structure of their division series and arms, they are to a certain extent intermediate between the species in the second and third groups within the genus *Himerometra* and the species of *Heterometra*.

The species in these last two groups are abruptly separated from all the other forms in the family Himerometridae by the enormous stoutness of the proximal pinnules. Indeed, pinnules of the type characteristic of these species are found elsewhere only in the genus *Cenometra* of the family Colobometridae in which P_2 is similarly modified. These two groups are distinguished from each other by the number of the segments in the proximal pinnules. In one group (including *H. sol* and *H. magnipinna*) the stout proximal pinnules have about 30 segments and taper slowly distally to a delicate tip, while in the other (including *H. robustipinna* and *H. martensi*) they are composed of about 20 segments and taper very rapidly. These two groups seem quite distinct; but it may be mentioned that in a specimen of *H. robustipinna* from the Kei Islands Reichensperger found P_D to be composed of 22–24 segments.

Each of the three groups is represented in the Malayan region from the Philippines to the Kei Islands—by *H. bartschi*, *H. magnipinna*, and *H. robustipinna*. But the two species included in each of the three groups always have distinct ranges that do not overlap. Thus *H. persica* is the western representative of the East Indian *H. bartschi*, *H. sol* is the western representative of *H. magnipinna*, and *H. martensi* represents the widely spread *H. robustipinna* at Singapore and in British North Borneo.

With the exception of *H. robustipinna*, specimens of all the species from any one locality are very uniform in their characters. But *H. robustipinna*, which appears to have the most extensive range of all the included forms, seems to be very variable. This variation does not seem to be geographical, for Reichensperger has pointed out that a specimen from the Philippines (the type of my *H. robustipinna*) is unquestionably the same as Hartlaub's specimen (the type of *Antedon kraepelini*) from Burma, and at the same time he recorded two specimens from the Kei Islands in one of which P_D has 22–24 segments while in the other it has only 18–20 segments.

The species of the genus *Himerometra* are among the very largest of the tropical comatulids, being exceeded in size, when fully developed, only by the largest species of Comasteridae and perhaps by *Pontiometra andersoni* in the Colobometridae. They are all inhabitants of very shallow water, none having been recorded from a depth greater than 57, or possibly 66, meters. Specimens of all of them have been taken in shore collecting, although they are commonest a few meters beneath the surface.

History.—The genus *Himerometra* was first proposed, with the genotype *Antedon crassipinna* Hartlaub, 1890, in a revision of the old genus *Antedon* published by me in 1907. At that time it was considered as including all the multibrachiate species of comatulids with unplated ambulacra except those in the family Comasteridae and those assigned to the genera *Zygometra*, *Pontiometra*, and *Cyllometra*, which were described at the same time; a few 10-armed species, now placed in the genera *Amphimetra* and *Oligometrides*, were also assigned to it.

In a revision of the family Himerometridae published in 1909 the genus *Himerometra*, by the removal of various species to the new genera *Amphimetra*, *Cenometra*, *Craspedometra*, *Stephanometra*, *Heterometra*, and *Dichrometra*, was restricted to its present limits, except only that *Himerometra philiberti* (J. Müller) was retained in it with a query.

KEY TO THE SPECIES IN THE GENUS HIMEROMETRA

a^1. Enlarged proximal pinnules very stout with all, or nearly all, of the component segments broader than long, or at least as broad as long; none of the segments in the proximal pinnules are carinate; following pinnules without carinate processes on the earlier segments.

  b^1. Enlarged proximal pinnules with about 30 segments, very stout basally and distally tapering gradually to a delicate and more or less flagellate tip; the distal edges of the segments in the middle half or proximal two-thirds of the proximal pinnules are swollen and may be strongly everted, but they are always smooth, never spinous.

c^1. Cirri very stout, stouter than in any other species of the genus; the enlarged proximal pinnules have the segments in the basal two-thirds with strongly produced and everted distal edges (Maldive Islands)________________**sol** (p. 188)

c^2. Cirri rather short and weak, without, or with only slight traces of, dorsal processes on the distal segments; the enlarged proximal pinnules have the segments in the middle half with slightly swollen distal edges (from Cochinchina and Philippines south to southern Celebes and Kei Islands and eastward to Admiralty Islands; 0–38 meters)___**magnipinna** (p. 189)

b^2. Enlarged proximal pinnules with about 20 segments, distally tapering more or less abruptly and without a flagellate tip.

c^1. Segments of the enlarged proximal pinnules entirely smooth; the distal edges of the component segments may be swollen, or they may be unmodified, but they are never spinous; distal edges of the proximal brachials smooth, or only very slightly produced (from Philippine Islands and Macclesfield Bank southward to Moluccas, Kei Islands, and Great Barrier Reef and westward to Ceylon; 0–57 [?66] meters)__________**robustipinna** (p. 193)

c^2. Segments of the enlarged proximal pinnules with the distal ends projecting abruptly beyond the bases of the segments succeeding (but not overlapping) and armed with very numerous fine spines (in large specimens on the distal segments only); distal ends of the proximal brachials very strongly produced and everted (Singapore and North Borneo; littoral) **martensi** (p. 203)

a^2. Enlarged proximal pinnules slender, flagellate distally, and very long (slightly more than half the length of the cirri), composed of 36–40 perfectly smooth segments most or all of which are longer than broad; a few of the earlier segments are narrowly, but prominently, carinate; earlier segments of the following pinnules very strongly carinate; segments in the outer half of the cirri with prominent dorsal spines.

b^1. Arms 35–61 in number; about 40 cirrus segments; a few of the basal segments in the proximal pinnules are broader than long (from Philippine Islands and Singapore south to Amboina and Kei Islands; 0–51 meters)____________**bartschi** (p. 209)

b^2. Arms 20–25 in number; about 35 cirrus segments; all the segments in the proximal pinnules are longer than broad (Persian Gulf)____________**persica** (p.212)

HIMEROMETRA SOL A. H. Clark

Antedon palmata Bell, *in* Gardiner, Fauna and geography of the Maldive and Laccadive Archipelagoes, vol. 1, pt. 3, 1902, p. 224 (Kolumaduli, Maldives; 38 fathoms).

Himerometra sol A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 40 (identity of Bell's record), p. 115 (synonymy; detailed description, based on Bell's specimens; locality); Proc. U. S. Nat. Mus., vol. 46, 1913, p. 285 (in key), p. 288 (synonymy; range); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 26 (published reference to specimens in B. M.; locality; detailed description of 1 specimen and shorter description of another); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 73 (in key; range); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, pp. 99 (range), 103.

Diagnostic features.—The enlarged proximal pinnules are very stout basally, distally gradually tapering to a delicate and flagellate tip; they are composed of 30–32 segments nearly all of which are broader than long, or at least not longer than broad; the distal edges of the segments in the middle half or proximal two-thirds are strongly produced and everted, but are always smooth and never spinous; none of the segments of the proximal pinnules are carinate, and the following pinnules are without carinate processes on the earlier segments. The cirri are very stout, stouter than those in any other species of the genus, 25–30 mm. in length, with 25–30 segments, of which the outermost 10–12 have a small and low dorsal tubercle. The 41–51 arms are 140 mm. long.

Description.—The centrodorsal is thick discoidal, with a strongly concave dorsal pole 4 mm. in diameter.

The cirri are XXI, 25, 27, 28, and 30, from 25 to 30 mm. long; the longest segments, in the basal third, are nearly or quite as long as broad; the distal segments are slightly broader than long, sometimes as much as one-third again as broad as long; the terminal 10 or 12 segments have a small and low median dorsal tubercle, sometimes scarcely noticeable until near the end of the cirrus. The opposing spine is well developed and conspicuous. The cirri as a whole are stout, stouter than in the other species of the genus, with approximately subequal segments.

The IIBr series are 4(3+4). The IIIBr series are 4(3+4) externally, 2 internally. IVBr series, when present, are 4(3+4). The division series resemble those of the other species of the genus.

The 41 arms of the type specimen are 140 mm. long, resembling those of related species.

P_D is 18 mm. long, with 30 to 32 segments, which are nearly twice as broad as long in the proximal half, becoming squarish in the distal third, and terminally twice as long as broad. After the fourth or fifth the segments develop strongly everted and produced distal edges, this character gradually dying away in the distal third; this eversion is smooth and not serrate. The proximal pinnules are very stout, but also very long, and taper distally to a flagellate tip as in *H. magnipinna;* but the eversion of the distal ends of the segments is much greater than in that species, and the cirri are much stouter.

Notes.—Another specimen has the cirri XXXV, 27–29. There are 51 arms. As in the type specimen the division series are strongly convex dorsally and well separated. Only one of the division series, an internally developed IIIBr series, is 2, all the others being 4(3+4). The proximal pinnules are exactly as in the type, and are 18–21 mm. long.

Locality.—Kolumaduli, Maldive Archipelago; 69 meters; Prof. J. Stanley Gardiner [Bell, 1902; A. H. Clark, 1912, 1913] (2, B. M.).

History.—The two specimens upon which this species is based were originally recorded by Prof. F. Jeffrey Bell under the name of *Antedon palmata* in 1902. I examined them at the British Museum in 1910 and described them as representing a new species, *Himerometra sol,* in 1912. They were redescribed in my notes on the crinoids of the British Museum in 1913.

HIMEROMETRA MAGNIPINNA A. H. Clark

PLATE 15, FIGURES 54, 55; PLATE 16, FIGURE 56; PLATE 17, FIGURES 61, 62.

[See also vol. 1, pt. 2, fig. 260 (arm), p. 205; fig. 271 (arm and pinnules), p. 207; fig. 715 (disk) p. 346.]

Antedon crassipinna (part) HARTLAUB, Nachr. Ges. Göttingen, May 1890, p. 185 (specimen from Cochinchina, but not described specimen from Amboina [=*H. robustipinna*]); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 32 (specimen from Cochinchina, but not those from Amboina), p. 34 (characters of proximal pinnules), not pl. 1, figs. 1, 5, 10=*H. robustipinna.*—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 2 (Cochinchina), p. 4 (French Indochina).

Himerometra crassipinna A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (in part; listed); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Crinoids of the Indian Ocean, 1912, p. 116 (record from Cochinchina).

Himerometra magnipinna A. H. Clark, Smithsonian Misc Coll., vol. 52, 1908, p. 214 (description; *Albatross* stations 5139 and 5147); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Proc. U. S. Nat. Mus., vol. 39, 1911, p. 540 (Ulugan Bay, Palawan); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (*Antedon crassipinna* Hartlaub, in part), p. 17 (Cochinchina; detailed description), p. 18 (additional localities; descriptions); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 394 (St. Mathias Island); Crinoids of the Indian Ocean, 1912, p. 114 (synonymy; Philippine Islands; St. Mathias Island; 0–21 fathoms); Proc. Biol. Soc. Washington, vol 26, 1913, p. 179 (range in east Asia); Proc. U. S. Nat. Mus., vol. 46, 1913, p. 285 (in key), p. 287 (synonymy; range); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (Malayan species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 74 (in key; range; synonymy; notes; station 209), p. 274 (listed).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 41 (details of arm structure), pp. 44, 51 (reversion), p. 77 (syzygies), p. 283, fig. 8, p. 45 (arm base), fig. 98, p. 87 (synarthrial face), figs. 144–148, p. 95 (pinnule articulations), fig. 149, p. 98 (same).—A. H. Clark, Treubia, vol. 14, livr. 2, 1933, p. 211 (Nassi Besar); Proc. Biol. Soc. Washington, vol. 47, p. 9, 1934 (first record from Singapore), p. 11 (Singapore; notes).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 41, 46, 47, 50, 52.—A. H. Clark, Temminckia, vol. 1, 1936, p. 302 (Ternate; notes).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol 7, No. 1, 1936, p. 2 (Cochinchina), p. 4 (French Indochina), p. 6 (range), p. 8 (Pulo Condor; notes).

Diagnostic features.—The enlarged proximal pinnules are long, very stout basally, and gradually taper distally to a delicate and flagellate tip; they are composed of 28–42 (usually 30–35) segments, nearly all of which are broader than long, or at least as broad as long; the distal edges of the segments in the middle half of the proximal pinnules are swollen but are smooth and not spinous; none of the segments of the proximal pinnules are carinate, and the following pinnules are without carinate processes on the earlier segments. The cirri are rather short, 25–41 (usually 30–35) mm. in length, and are composed of 28–40 (usually 30–35) segments of which the distal are wholly without, or bear only very slight, dorsal processes. There are 33–62 (usually about 45) arms which are 130–184 (usually about 145) mm. long.

Characters of the type specimen.—The cirri are XV, 28–32 (usually 28–30), 30 mm. long. The distal segments are smooth, or bear only very faint dorsal tubercles. The 62 arms are 120 mm. long. The proximal pinnules are very stout and very long, tapering evenly from the base to the tip; they are composed of 28–29 segments of which the distal ends are slightly swollen but are not spinous or overlapping.

Notes.—Hartlaub said that the specimen from Cochinchina, which he referred to *H. crassipinna*, is of a beautiful purple-violet color. In contrast to the conditions in the three specimens of *H. crassipinna* he described, the IBr_1 are entirely free laterally. There are 45 arms of which some on the outer side of the postradial series arise directly from a IIBr axillary. Compared with the specimens of *H. crassipinna* P_D is relatively very long, reaching about 28 mm., and, in common with the pinnules following, it is somewhat more slender than the corresponding pinnules in *H. crassipinna*.

I examined this specimen in the Hamburg Museum. The cirri are about XXX (with some undeveloped), 28–32, from 35 to 41 mm. long. The cirri are moderately stout. The longest proximal segments are slightly broader than long. There are no dorsal spines, but the dorsal surface of the short distal segments is convex. The antepenultimate segment bears a small tubercle which quickly becomes obsolete on the one or two preceding segments. The 45 arms are 160 mm. long. P_D is 28 mm. long, with 33–34 segments, very stout basally and tapering evenly to a delicate tip. The earlier segments are twice as broad as long, those following gradually increasing in length and becoming about as long as broad on the fourteenth, and twice as long as broad on the small terminal segments. The segments in the middle half of the pinnule have the distal dorsal edge slightly swollen and prominent. P_P is 26 mm. long, with 33 segments, and is similar in every way to P_D. P_1 is 18 mm. long, with 25 segments, similar to the preceding pinnules but proportionately smaller. The cirri, centrodorsal, and division series are pinkish flesh color, the arms are slaty, and the proximal pinnules and the outer portion of the middle and outer pinnules are pinkish.

Of the specimens from Port Galera, Mindoro, one (original No. 202) has 58 arms 140 mm. long; another (original No. 224) has 51 arms; a third (original No. 150) has 40 arms and 35–38 cirrus segments; in this individual the proximal pinnules are very large and stout, long, with 23–28 segments, and without a flagellate tip but tapering gradually distally; a fourth specimen has 33 arms; this last in life had the bases of the arms whitish or light straw color, the arms transversely barred with brown, the pinnules barred whitish and brown, and the anal tube straw color spotted with light brown. In its present dry condition it is a uniform purplish brown.

In the specimen from Pulo Condor, Cochinchina, as described by Gislén, the arms are broken and the cirri have been lost. The centrodorsal bears sockets for XXXIV cirri. The IIBr series are 4(3+4) and the IIIBr series 2, the latter usually developed internally. There are 28+ arms. P_P is about 15 mm. long, with 19 segments, very stout, tapering distally, composed of smooth and short segments of which the longest are scarcely as long as broad; there is a slight constriction at the articulations, which makes the pinnule appear somewhat knobby. The pinnules are mostly broken at the tips. The color is violet. Gislén says that because of the rather small size and few arms this must be considered as a young individual.

The specimen from Ulugan Bay, Palawan, is a magnificent example of the species with 42 arms 184 mm. long and the cirri XXXIII, 29–35, 30 mm. long. The color in alcohol is a uniform deep violet.

One of the specimens from Bantayan Reef, Cebu, has 46 arms. In life the center of the dorsal surface was dull ochre, and the arms were crimson shading to rich chocolate at the tips. In the present dried condition it is a uniform brown.

The single broken specimen from Isabela, Basilan, has 40 arms. The cirri are 32 mm. long and are composed of 32 segments of which the terminal 15 have a minute submedian tubercle, which increases in size distally. The distal edges of the segments of the proximal pinnules, which are large and very stout, are everted but not spinous. The IIBr series are 4 (3+4). The IIIBr series are 4 (3+4) externally and 2 internally, or all 4 (3+4). The following division series, when present, are 4 (3+4).

In the fragmentary specimen from Ekalin, St. Matthias Island, the cirri and lower pinnules are very slightly stouter than they are in the specimen just preceding, and the segments of the lower pinnules have less prominent distal ends.

The three fine specimens from Pitilu, Admiralty Islands, have 36, 44, and 47 arms 130 mm. long.

The specimen from Ternate has 45 arms.

The specimen from the Danish Expedition to the Kei Islands station 11 has about 40 arms 140 mm. long. The cirri are XXVII, 39–40, 35 mm. long. P_D has 42 segments, and P_1 has 42 segments and is 25 mm. long.

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One of the specimens from Toeal has 46 arms 135 mm. long and the cirri XXVI, 28–30, 25–30 mm. long, mostly about 30 mm. long. One external IVBr 4 (3+4) series bears externally an arm and internally a first brachial from which arises a pinnule the base of which is about half as broad as the distal face of the first brachial.

The other specimen is similar, with 44 arms 130 mm. long and the cirri XXVI, 26–27, 25 mm. long.

The specimen from *Siboga* station 209 is small and immature with 12 arms 45 mm. long. Two IIBr 4 (3+4) series are developed on a single postradial series. The cirri are XV, 18–21, 17 mm. long. The longer proximal cirrus segments are half again as long as broad and are constricted centrally so that the cirri, which are rather slender, have very much the appearance of the cirri of *Stephanometra protectus* or of *Lamprometra palmata*. The dorsal pole of the centrodorsal is slightly concave. On the arms arising directly from the IBr axillaries P_1 is much larger than P_2, the relative proportions being the same as on the free undivided arms of the adults.

Localities.—Singapore, 1899 [A. H. Clark, 1934] (1, Raffles Mus.).

Singapore [A. H. Clark, 1934] (2, U.S.N.M., E. 3135).

Nassi Besar; 9 meters; otter trawl; June 4, 1908 [A. H. Clark, 1933] (1, Buitenzorg Mus.).

Cochinchina [Hartlaub, 1891; A. H. Clark, 1912] (1, H. M.).

Pulo Condor, Cochinchina; 15 meters; Dr. C. Dawydoff [Gislén, 1936].

Port Galera, Mindoro, Philippines; Dr. Lawrence E. Griffin (7, M. C. Z., 631 [original Nos. 88, 91, 100, 202], 681 [original No. 224], 682, 683 [original No. 150]).

Albatross, Ulugan Bay, Palawan; December 28, 1908 [A. H. Clark, 1911] (1, U.S.N.M., 35200).

Bantayan Reef, Cebu, Philippines; Dr. Lawrence E. Griffin (3, M. C. Z., 386, 394, 395).

Isabela, Province of Mindanao, Philippines; Dr. H. Hallier, January 22, 1904 [A. H. Clark, 1912] (1, H. M.).

Albatross station 5139; in the vicinity of Jolo (Sulu); Jolo light bearing S. 51° W., 3.6 miles distant (lat. 6°06′00″ N., long. 121°02′30″ E.); 36 meters; coral sand; February 14, 1908 [A. H. Clark, 1908] (1, U.S.N.M., 25440).

Albatross station 5147; Sulu Archipelago, in the vicinity of Siasi; Sulade Island (E.) bearing N. 3° E., 8.4 miles distant (lat. 5°41′40″ N., long. 120°47′10″ E.); 38 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1908] (1, U.S.N.M., 35198).

Ekalin, St. Matthias Island, Admiralty Islands; Dr. G. Duncker [A. H. Clark, 1912] (1, H. M.).

St. Matthias Island, Admiralty Islands; Herr Schöde [A. H. Clark, 1912] (1, Berl. M.).

Pitilu, Admiralty Islands; Dr. G. Duncker [A. H. Clark, 1912] (3, H. M.).

Ternate; 2–4 meters; *Willebrord Snellius*, June 6, 1930 (1, L. M.).

Danish Expedition to the Kei Islands station 11; Dr. Th. Mortensen; 20 meters; sand; April 9, 1922 (1).

Danish Expedition to the Kei Islands station 61; Dr. Th. Mortensen; about 50 meters; May 15, 1922 (1).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Vatek van Toeal; about 2 meters; rocky coast; March 23, 1922 (2).

Siboga station 209; anchorage off the south point of Kabaëna Islands (off southeastern Celebes); reef [A. H. Clark, 1918] (1, Amsterdam Mus.).

Geographical range.—From Singapore, Cochinchina, and the Philippines southward to Kabaëna Island and the Kei Islands, and eastward to the Admiralty Islands.

Bathymetrical range.—Littoral and down to 38 meters.

History.—The first known specimen of this species was recorded by Dr. Clemens Hartlaub from Cochinchina in 1891. He referred it to a new species from Amboina, which he described under the name *Antedon* [*Himerometra*] *crassipinna*, but he mentioned certain features whereby it differed from the three specimens he had from Amboina.

In 1908 I described the species from a specimen dredged by the *Albatross* in the Philippines at station 5139 and at the same time recorded another specimen from station 5147. In 1911 I recorded an additional example, which had been collected by the *Albatross* at Palawan.

In my monograph of the crinoids of the Indian Ocean published in 1912, I gave this species from the Philippines and from St Matthias Island, the latter locality being taken from the labels of unrecorded specimens in the Hamburg and Berlin Museums. Hartlaub's specimen from Cochinchina I included with a query under *H. crassipinna*. In a paper on the crinoids of the Hamburg Museum published in the same year, I referred Hartlaub's Cochinchina specimen definitely to *H. magnipinna*, and recorded one specimen from Isabela, Basilan, another from Ekalin, St. Matthias Island, and three from Pitilu in the Admiralty Islands. In a paper on the crinoids of the Berlin Museum published two weeks later, I recorded another specimen from St. Matthias Island.

In 1918 I recorded and gave notes upon a very small specimen which had been dredged by the *Siboga* at station 209.

Dr. Torsten Gislén in 1924 described and figured various structural features of this species, but did not give the origin of his specimen.

In 1933 I recorded a specimen from Nassi Besar in the collection of the Buitenzorg, Java, Museum, and in 1934 I recorded three specimens from Singapore, one dated 1899, in the collection of the Raffles Museum, Singapore.

In 1936 Dr. Gislén recorded and gave notes upon a young specimen from Pulo Condor, Cochinchina.

HIMEROMETRA ROBUSTIPINNA (P. H. Carpenter)

PLATE 16, FIGURE 60; PLATE 17, FIGURE 63; PLATE 18, FIGURES 68, 69

[See also vol. 1, pt. 2, fig. 270 (arm and pinnules), p. 207; fig. 714 (disk), p. 346.]

Actinometra robustipinna P. H. CARPENTER, Notes Leyden Mus., vol. 3, 1881, p. 201 (description; Moluccas); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 59, 330, 345, 367, 383.—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 37, 1909, p. 30 (appears to be a synonym of *Alecto bennetti*); Notes Leyden Mus., vol. 33, 1911, p. 176 (identified as *Himerometra*, sp.; doubtfully referred to *H. crassipinna* from Singapore [*martensi*]); Crinoids of the Indian Ocean, 1912, pp. 116, 117 (same).

Antedon kraepelini Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 183 (description; Akyab, Burma); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 22 (detailed description; Akyab), pl. 2, figs. 15, 21.—A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 18 (type seems to be a small *robustipinna*).

Antedon crassipinna Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 185 (description; Amboina [specimen from Cochinchina is *H. magnipinna*]); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 11 (collected by Brock at Amboina), p. 19 (in key), p. 32 (detailed description and comparisons; Amboina [specimen from Cochinchina is *H. magnipinna*]), p. 113 (in Göttingen Mus.), pl. 1, figs. 1, 5, 10.—A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (=*Himerometra crassipinna*, in part); Crinoids of the Indian Ocean, 1912, p. 37 (same).

Antedon inopinata Bell, Proc. Zool. Soc. London, 1894, p. 398 (description; Macclesfield Bank, 31–36 fathoms).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 477 (not recognizable from description; placed in wrong "group"); Crinoids of the Indian Ocean, 1912, p. 38 (of Bell, 1894=*Himerometra inopinata*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 83 (of Bell, 1894=*Himerometra robustipinna*).

Antedon crassispina Koehler, Mém. Soc. Zool. France, vol. 8, 1895, p. 420 (Sunda Islands; Biliton; notes).

Himerometra crassipinna A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Notes Leyden Mus., vol. 33, 1911, p. 183 (possibly species represented by type of *Actinometra robustipinna*); Crinoids of the Indian Ocean, 1912, pp. 36, 37 (identity), p. 116 (Amboina [records from Singapore and Pulau Ubin are *H. martensi*, and those from Cochinchina are *H. magnipinna*]).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 83 (Kei Islands), p. 98 (Nuhu-Tawan, north coast of Little Kei; characters of the 4 specimens).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 74 (of Reichensperger=*H. robustipinna*).

Himerometra kraepelini A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Crinoids of the Indian Ocean, 1912, p. 116 (synonymy; locality).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 83 (Ceylon), p. 96 (Ceylon, Sarasin; characters; discussion), p. 98 (synonymy; further discussion).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 74 (identity).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 48.

Comaster robustipinna A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1908, p. 686 (listed).

Phanogenia robustipinna A. H. Clark, Proc. U. S. Nat. Mus., vol. 35, 1908, p. 124 (listed).

Himerometra robustipinna A. H. Clark, Smithsonian Misc. Coll., vol. 52, 1908, p. 213 (new species; description; *Albatross* Sta. 5165), p. 214 (compared with *H. magnipinna*); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 10 (*A. kraepelini* possibly a synonym of this); Crinoids of the Indian Ocean, 1912, p. 114 (of A. H. Clark, 1908, renamed *H. pulcher*).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, pp. 97, 98.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 46, 1913, p. 285 (in key), p. 286 (of P. H. Carpenter, 1881; synonymy; range); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 25 (reference to the specimen in B.M. [*inopinata* of Bell, 1894]; locality; detailed description); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 74 (in key; range).—H. L. Clark, Rec. Australian Mus., vol. 15, No. 2, 1926, p. 184 (off Ellison reef; 5–15 fathoms).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 48; Kungl. Fysiogr. Sällsk. Lund Forh., vol. 7, No. 1, 1936, p. 5 (range).

Himerometra sp. A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 176 (*Actinometra robustipinna*), p. 182 (Moluccas; description; appears to be *H. crassipinna* [*martensi*]); Crinoids of the Indian Ocean, 1912, p. 117 (synonymy; remarks on the type of *Actinometra robustipinna* P. H. Carpenter, 1881; possibly *H. crassipinna* [*martensi*]); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (*Antedon kraepelini*), p. 18 (locality; appears to be a small *robustipinna* [of A. H. Clark, 1908]).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 98.

Himerometra pulcher A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 114 (new name for *Himerometra robustipinna* A. H. Clark, 1908, not *Actinometra robustipinna* [*Himerometra*, sp.] P. H. Carpenter, 1881; synonymy; locality); Proc. U. S. Nat. Mus., vol. 46, 1913, p. 287 (synonym of Carpenter's *robustipinna*).—REICHENSPERGER, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 97 (synonym of *kraepelini*), p. 98 (further discussion).

Himerometra inopinata A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 114 (type of *Antedon inopinata* Bell, 1894, redescribed and shown to be a *Himerometra;* correction of the original depth record).

Diagnostic features.—The enlarged proximal pinnules are very stout and taper rapidly to the tip; they are composed of 17–24 (but almost always 20) segments of which the distal ends may be unmodified or swollen, but are never spinous; the distal edges of the proximal brachials are smooth, or only slightly produced. There are 37–56 (usually about 45) arms, which are 100–200 (usually 130–140) mm. long.

Description.—The centrodorsal is as in the other species of the genus.

The cirri are XXX, 26–34, stout, 30–35 mm. long. The sixth or seventh segments are the longest, from slightly broader than long to half again as broad as long. The distal segments are slightly carinate, the carination on the last six or seven ending distally in a small spine.

Nine of the IIBr series are 4 (3+4) and two are 2; the IIIBr series are all 4 (3+4) except one, internally developed; the remaining division series are all 4 (3+4) except two IVBr series, which are 2. The division series are strongly convex and well separated as is usual in the genus.

The 46 arms are 140 mm. long and resemble those of the other species of the genus.

The proximal pinnules are very stout but nearly smooth, the distal edges of the segments being only very slightly swollen. All the segments are short, about twice as broad as long in the proximal half, becoming squarish toward the tip. The proximal pinnules are about 20 mm. long, with 17–20 segments.

Notes.—The specimen from *Albatross* station 5165, which was described as the type of a new species *Himerometra robustipinna,* has 37 arms 100 mm. long. The cirri are XVIII, 30–40, 35 mm. long; they are without dorsal spines, though the last three segments may have small median tubercles. The proximal pinnules are very stout, with most of the segments, which number about 20, broader than long and smooth. P_D is 15 mm. long.

In the type specimen of *Antedon inopinata* from the Macclesfield Bank, according to Bell, the centrodorsal is large, hollowed in the center, which is bare of cirrus pits; the cirri are arranged in three irregular rows on the side. The cirri are long and stout, about XLV, about 40, up to 28 mm. in length; the terminal segments are faintly spinous. The radials and the IBr_1 are broad and stout, and the IBr_2 (axillaries) are short at the side. The IIBr series are 4 (3+4). There are nearly always IIIBr 4 (3+4) series present. In rare cases there may be IVBr 2 series. The arms are about 45 in number, and are about 100 mm. long. The brachials are wide, low, and very regular and are much compressed laterally. Syzygies occur between brachials 3+4, then not again for about 26 muscular articulations. The pinnules generally are pretty stout and stiff, the basal ones being very markedly stout. The color in alcohol is light brown, with the ambulacral surface of the pinnules somewhat darker.

Dr. P. H. Carpenter described *Actinometra robustipinna* as follows: The centrodorsal is a thick disk slightly flattened at the dorsal pole and bearing about 40 cirrus sockets in 2 marginal rows. The radials are partially visible all around the calyx, but they diverge slightly at each angle so as to leave a gap. This is bridged over by the proximal portions of the short IBr_1 which have lateral extensions meeting those of their fellows on either side. The IBr_2 (axillaries) are pentagonal, quite free laterally, and rather more than twice as long as the IBr_1, with moderately sharp distal angles. The post-radial series may divide three times. Six of the IIBr series are 4(3+4) and three are 2; the remaining one is broken away. The IIIBr series, when present, are 4(3+4). The first ossicles beyond each axillary are closely united laterally. The total diameter between IIIBr axillaries is 25 mm.

There are 17+ arms. The pinnules borne by the second ossicles after each axillary are enormously large and stout, so much so that the ossicles bearing them have almost the appearance of being axillaries themselves. Each pinnule contains 20+ massive segments the ventral edges of which are produced so as to stand up as plates sloping slightly inward toward the ambulacral groove. The disk is lost. The diameter of the centrodorsal is 7 mm. The color is light brownish white.

Carpenter said that, although no traces remain either of the disk or of a terminal comb on the oral pinnules, the flattened calyx and the wide funnel in the center of the radial pentagon indicate the generic position of this specimen, which is markedly different from most species of *Actinometra* that he had seen.

I examined the type specimen of Carpenter's *Actinometra robustipinna* at Leyden in 1910, and in 1911 I wrote that it proved to be a specimen of a typical species of *Himerometra*. All the IIIBr series are 4(3+4). The proximal pinnules are very large and stout, the tips ending bluntly after a considerable recurve. So far as they are preserved the segments are broader than long. The distal ends are not thickened or produced, though appearing slightly prominent and a trifle swollen. One P_2 with 18 segments appears to be complete.

The three specimens collected by Dr. J. Brock at Amboina were described by Hartlaub as a new species, *Antedon crassipinna*, in the following terms: The centrodorsal is broad and thick, rather deeply concave in the middle; the cirri are arranged in three marginal rows. The cirri are about XXXVII, 30–40, reaching 46 mm. in length. None of the segments are longer than broad. Toward the ends the cirri become compressed laterally and the outermost segments bear small spines. The radials are entirely concealed, or only in small part visible. The IBr_1 are partially united laterally. The IBr_2 (axillaries) are pentagonal. There are 2 or 3 division series beyond the IBr series. The IIBr series are 4(3+4), or some of them may be 2. The IIIBr series are 2 and 4(3+4), sometimes the inner on a post-radial series being 2 and the outer 4(3+4), while in other cases they are mostly 4(3+4). All the IVBr series are 4(3+4). The axillaries of the division series are rather large. The ossicles following the axillaries are always partially united laterally. On the articulation between the two first elements of each division series there is a dorsal tubercle, though this may be scarcely noticeable; a similar tubercle occurs on the articulation between the first two brachials, though here it is less marked. The axillaries of the division series of 4(3+4) form with the segment succeeding sometimes a small lateral boss over the base of the pinnule. The 46–56 arms are about 200 mm. long. They have a narrow dorsal surface and a serrate dorsal profile, and are composed of short uniform brachials. From the very base of the arm the brachials have produced distal ends, this feature becoming less and less marked toward the arm tips so that here the surface of the arms is fairly smooth. The six or seven earliest brachials, especially the first

4, are somewhat longer than those following, which are shortly discoidal and in general very uniform. Syzygies occur between brachials 3+4, again from between brachials 23+24 to between brachials 31+32, and distally at intervals of 13–15 muscular articulations.

The pinnules on the division series and P_1 in their great thickness, size and stiffness contrast strikingly with the pinnules following. They have thick cylindrical segments with especially thickened distal ends which with smooth edges overlap the bases of the segments succeeding. P_D and P_P are of about equal size, about 20 mm. in length and composed of about 20 segments. P_P on the inner IIIBr series is somewhat smaller than on the outer. The pinnule on the IVBR series is somewhat shorter. P_1 on the outer arms is about 16 mm. long, but on the inner arms markedly shorter. The following pinnules vary a little in their length, but are always much smaller and weaker. Their length decreases to the pinnule of the eleventh brachial. The pinnules succeeding become larger again, reaching up to about 10 mm. in length. P_a is 10 mm. long, about as long as P_b. The segments of these pinnules have sometimes short lateral processes on their distal ends. The disk is incised, and is 32 mm. in diameter. Sacculi are crowded on the pinnules. The color is purple-violet or chocolate-brown.

While the preceding description is based wholly upon Professor Brock's three specimens from Amboina, Hartlaub included in his account as a representative of this species a specimen from Cochinchina in the Hamburg Museum, which in reality represents *H. magnipinna.*

Hartlaub remarked that his new species is the largest of the known forms in the *Savignyi* group and has the largest number of arms. It is easily distinguished from all the others by its stout and massive lower pinnules. He said that it is especially interesting in possessing a feature that heretofore has not been observed in any endocyclic comatulid, although it occurs in several comasterids, that is, the presence in equal numbers of IIIBr 2 and IIIBr 4(3+4) series. He pointed out that while in the comasterids the inner IIIBr series are 4(3+4) and the outer are 2, the reverse is the case in this species. He also noticed that both in this form and in the comasterids this arrangement is not wholly constant. He mentioned that while one or two IVBr series may occur on the inner IIIBr series, on the outer IIIBr series there is usually none, although there may be one. He discussed the presence of IIBr 2 series, of which one of the specimens from Amboina possessed three, and said that this variation in the number of elements in the IIBr series seems not to be unusual, as it occurs in *Craspedometra acuticirra*, *Heterometra nematodon*, and *Adelometra angustiradia* (the last, although a macrophreate form, was placed in the *Savignyi* group by Carpenter). But he noted that in these species it is not so developed as it is in *Comanthus parvicirra*, which is characterized by the greatest irregularity in this respect.

Speaking of the specimens from Little Kei, Dr. August Reichensperger said that Dr. Merton obtained four individuals of this well-characterized and fairly stable species with 36, 39, 45, and 47 arms 130 to 140 mm. in length. There is little correlation between the arm number and the size of the individuals. Except for one, all have a smaller arm number than was given by Hartlaub. Reichensperger remarked that in his specimens he confirmed the alternation of IIIBr 2 and IIIBr 4(3+4) series noted by Hartlaub. He said that in general the outer IIIBr series are 2 and the inner 4(3+4). This, however, is a slip; he meant to say just the opposite, as is shown by his details of the division of two postradial series given below. The number of IIIBr 2 and IIIBr 4(3+4) series he found to be approximately the same, and only in a single specimen did the IIIBr 4(3+4) series strongly predominate. He found the IIBr series 2 in a few cases. He gave two examples of the arm division in his specimens. In one of these one of the IIBr series is 4(3+4) and the other is 2. The IIIBr series are 4(3+4) externally and 2 internally. The two inner IIIBr series bear next to the midradial line of the postradial series as a whole a IVBr series, both of these adjacent IVBr series being 4(3+4). The outer IIIBr series following the IIBr 2 series bears a IVBr 2 series on the outermost side of the postradial series as a whole. In the other example of arm division both IIBr series are 4(3+4), and the IIIBr series are 4(3+4) externally and 2 internally. There are two IVBr series, one next to the midradial line of the postradial series as a whole on either side; one of these is 4(3+4) and the other is 2.

The cirri of these specimens are up to 42 mm. in length and consist of 28–38 segments of which the distal are mostly quite without dorsal spines. P_D and P_1 are almost equal. P_D in the largest specimen has 22–24 segments and in the smaller 18–20. The segments are thick discoidal, broader than long, being longer than broad only in regenerating pinnules. These pinnules measure 19–22 mm. in length. The lower pinnules to and including P_3 and P_6 have entirely smooth overlapping distal ends. Reichensperger noted that I had said that in smaller animals with P_D only 13 mm. long the segments of that pinnule have produced and spinous distal ends. My remark referred to specimens from Singapore (*H. martensi*), which at the time (1909) I believed to be conspecific with Hartlaub's specimens from Amboina.

In Reichensperger's specimens the diameter of the disk is about 25 mm. The color in alcohol is dark red-brown.

One of the specimens from the Great Barrier Reef, as described by Dr. H. L. Clark, has 29 arms and the cirri about XXX, 27–29. The other has 36 arms and the cirri are XXXII, 29–33. In both specimens the cirri have the dorsal spines confined to the outermost segments; seldom more than six segments show the spines clearly, and often only one.

The specimen from Biliton recorded by Professor Koehler is not completely developed. There are 36 arms, which do not exceed 80 mm. in length, and IVBr series are not present on all the rays. One of the IIBr series and two of the IIIBr series are 2; all the other IIBr, IIIBr, and IVBr series being 4(3+4).

The specimen from Akyab on the Burmese coast was described by Hartlaub as a new species under the name *Antedon kraepelini*. The centrodorsal is thick, strongly concave in the middle of the dorsal surface, with the sides swollen. There were about XXX cirri of which only two stumps remain. The radials are only slightly visible; they are separated laterally. The IBr_1 are entirely free laterally. The IBr_2 (axillaries) are rather short, and are pentagonal. The IIBr series are 4(3+4). The inner IIIBr series are always 2, and the outer are often 4(3+4). The articulations between the elements of the division series are smooth. The two ossicles immediately following each axillary are partially united interiorly. There are 33 rough and rather short arms from 40 to 50 mm. long which taper rapidly. From about the ninth onward the brachials are very short and wedge-shaped with rather strongly produced distal ends. In the distal half of the arms they again become more discoidal. The proximal brachials are discoidal and have smooth articulations. The first brachial syzygy is between brachials 3+4, the second is at about brachials 24+25, and the distal intersyzygial interval is usually 9 muscular articulations.

P_D and P_P are thick and massive. P_D is about 13 mm. long and is composed of about 18 approximately squarish segments which gradually become somewhat more slender toward the end of the pinnule. P_P is of the same form and sometimes also of almost the same length. P_1 on the outer arms has a similar form at the base but it is much shorter and after the basal segments quickly becomes slender. On the inner arms P_1 is markedly weaker. P_a is extraordinarily small. The following pinnule pairs, especially from the third onward, are very small and are of about the same length. From the fifteenth brachial onward they very gradually become larger though they do not reach more than 5 mm. in length. The sacculi on the pinnules are small and scattered. The disk is lacking.

Hartlaub said that this specimen is unfortunately much broken, the cirri and most of the arms having been lost. He said that the species represented is remarkable for the thickness of the proximal pinnules, which is the more noticeable as the more distal pinnules are unusually small and slender. He regarded the shortness and rapid taper of the arms as noteworthy, this being in contrast to the central portion of the animal which has a stout centrodorsal and relatively strong first division series. He said that the new species seems to stand nearest to *Antedon* (*Himerometra*) *martensi* from which it differs, however, in the form of the centrodorsal, the arms, and the lower pinnules. The last are very massive in both species, but more so in *martensi* in which there is a special enlargement of the basal segments. Besides, in *martensi* the thick pinnules have an uneven surface due to the abrupt decrease in the size of their component segments, which is not the case in *kraepelini*. Also in *martensi* the strong production of the distal border of the brachials begins at the third brachial.

When at Hamburg in 1910 I examined this specimen. It appears to be a small specimen of *robustipinna* (that is, the form which I described as *robustipinna* in 1908) with which it agrees in the absence of a thickening or eversion of the distal ends of the segments of the enlarged proximal pinnules. The lack of the pinnule tips and of the cirri prevent a wholly satisfactory determination.

Under the name of *Himerometra kraepelini* Reichensperger recorded two well-preserved specimens from Ceylon. In the larger individual the centrodorsal is thick with a large concave dorsal pole. The cirri are arranged in two rows. The cirri are XXX, 25–30, from 27.5 to 35 mm. long. The first four or five segments are markedly broader than long, and that following is about as long as broad; the next five or six are somewhat longer than broad, but toward the end of the cirri the segments become again markedly broader than long. There are no dorsal spines, but the last three or four segments bear a very faint dorsal swelling. The antepenultimate segment has a small blunt spine. The terminal claw is short and curved. There are 46 arms 95 mm. long. There are up to four divisions. In their structure the arms agree completely with Hartlaub's description. The basal portion of the arms is smooth. From the last division onward the arms taper rapidly and are very rough with entirely discoidal brachials. P_D is the thickest and longest pinnule, stiff, the easily broken point turned somewhat outward. It is 14–15 mm. long and is composed of 14–18 segments, all of which are more or less squarish. The distal ends never overlap.

P_1 is similar in form but slightly shorter, with about 15 segments. P_3, in common with P_2, after the third or fourth segment begins to taper rapidly and becomes more flagellate, but it is rather rigid and is almost as long as P_2; it is composed of about 22 segments. P_4 is small and slender, only about one-third as long as P_3. The other characters agree entirely with those given by Hartlaub. The close placing of the short distal pinnules is especially striking. The color, as preserved, is ventrally dark red-brown, P_1 to P_4 being lighter. The cirri and the proximal portion of the arms is light brown, the arms becoming almost black distally.

In the second specimen from Ceylon the centrodorsal is thick with the dorsal pole rather large and concave. The cirri are arranged in two rows. The cirri are XXXII, 28–30, up to 35 mm. in length. As in the other individual the segments in the middle portion of the cirri are somewhat longer than broad—relatively slightly longer in this specimen than in the other. The 38 arms are about 80 mm. long. Their structure is the same as in the other. A number of arms are regenerating at the syzygy between brachials 3+4. In three cases an axillary is regenerating, and in five cases a new arm without an axillary. P_D and P_1 are relatively a little more slender than in the other specimen and not quite so straight and stiff; they are composed of 18 and 15 segments, respectively. The other characters are as given in the other individual. Unfortunately the pinnules are in part defective. The color is dark brown, almost blackish.

Localities.—*Albatross* station 5165; Tawi Tawi group, Sulu (Jolo) Archipelago; Observation Island bearing N. 70° W., 6.4 miles distant (lat. 4° 58′ 20″ N., long. 119° 50′ 30″ E.); 16 meters; coral; February 24, 1908 [A. H. Clark, 1908, 1912, 1913; Reichensperger, 1913] (1, U.S.N.M., 25439).

Macclesfield Bank; 57–66 meters; H. M. S. *Penguin* [Bell, 1894; A. H. Clark, 1908, 1912, 1913] (1, B.M.).

Albatross station 5644; Buton Strait, off southeastern Celebes; Makasser Island (E.) bearing N. 4° E., 1.3 miles distant (lat. 5° 27′ 24″ S., long. 122° 38′ 00″ E.); 40 meters; December 16, 1909 (1, U.S.N.M., 35971).

Moluccas; H. C. Macklot [P. H. Carpenter, 1881; A. H. Clark, 1911, 1912, 1913] (1, L.M.).

Amboina; Dr. J. Brock [Hartlaub, 1890, 1891; A. H. Clark, 1912, 1913].

Kei Islands; Nuhu-Tawan, northern coast of Little Kei; Dr. H. Merton, June 16, 1908 [Reichensperger, 1913; A. H. Clark, 1918].

Off Ellison Reef, outer Great Barrier Reef, Queensland; 9–27 meters; Surgeon Lt. Comdr. W. E. J. Paradice, H. M. S. *Geranium*, August 1924 [H. L. Clark, 1926].

Biliton, Sunda Islands; M. Korotnev, 1885 [Koehler, 1895; A. H. Clark, 1913].

Akyab, Burma [Hartlaub, 1890, 1891; A. H. Clark, 1911, 1912, 1913] (1, H.M.).

Ceylon; Doctor Sarasin [Reichensperger, 1913; A. H. Clark, 1918].

Geographical range.—From the Philippine Islands and the Macclesfield Bank southward to the Moluccas, the Great Barrier Reef, and the Kei Islands and westward to Ceylon.

Bathymetrical range.—Littoral and down to 57 (?66) meters.

Remarks.—Although all the specimens listed appear to be conspecific, there is considerable variation in the enlarged proximal pinnules. The segments of these pinnules are smooth and cylindrical with unmodified distal ends in the type of Carpenter's *Actinometra robustipinna* from the Moluccas, in the type of my *Himerometra robustipinna* from *Albatross* station 5165, in the type of Hartlaub's *Antedon kraepelini* from Akyab, Burma, and in Reichensperger's specimens from Ceylon. In the two specimens of Bell's *Antedon inopinata* from the Macclesfield Bank the distal ends of the segments of the enlarged proximal pinnules are very slightly swollen, while in Hartlaub's three specimens of *Antedon crassipinna* from Amboina and in Reichensperger's specimens from Little Kei the distal ends of the segments are thickened and overlap the bases of the succeeding segments.

In all cases P_D has about 20 segments (17–20), except that in one of the specimens from Little Kei described by Reichensperger it has 22–24 segments. This specimen would seem to show an approach to *H. magnipinna.*

History.—The history of this species is curiously involved. It was first described from a much mutilated specimen from the Moluccas as a species of Comasteridae, *Actinometra robustipinna*, by Dr. P. H. Carpenter in 1881.

In the *Challenger* report on the comatulids published in 1888 Carpenter inserted *Actinometra robustipinna* in the key to the species of the *Parvicirra* group of *Actinometra* where it was given as having IIIBr 4(3+4) series, but no IVBr series, 30 or more cirri of (by inference) 15–20 segments, and the pinnules on the division series very large and stout. In discussing *Comanthus trichoptera* Carpenter said that *robustipinna* resembles it in the presence of a large number of cirri, but is readily distinguished by the great size of its first three pinnules.

In 1890 Dr. Clemens Hartlaub described *Antedon kraepelini* from Akyab, Burma, and *Antedon crassipinna* from Amboina, including with the latter as conspecific a specimen in the Hamburg Museum from Cochinchina. He redescribed these two species in greater detail and figured them in the following year. In the key to the species which he discussed in his memoir he placed *Antedon kraepelini*, paired with *A. martensi*, under the heading IIIBr 2, and P_D very stout. But he mentioned in the key that in *kraepelini* the outer IIIBr series are often 4(3+4). He placed *Antedon crassipinna* under the heading IIIBr series 2 and 4(3+4), together with *Antedon bipartipinna* (=*acuticirra*). His description of *Antedon kraepelini* immediately follows that of *A. martensi*, but the description of *Antedon crassipinna* is many pages farther on, separated from the description of *A. kraepelini* by the descriptions of *Antedon brockii*, *A. affinis*, and *A. nematodon* and a discussion of *A. ludovici.* In his description of *Antedon kraepelini* he said that the inner IIIBr series are always 2, but the outer are often 4(3+4). He seems to have attached no importance to this in *A. kraepelini*, but in his account of *A. crassipinna* he discussed at considerable length the curious arrangement of the IIIBr series which are 2 internally and 4(3+4) externally.

In his remarks under *Antedon kraepelini* Hartlaub said that the short and rapidly tapering arms are in strong contrast to the central portion of the animal, which has a large centrodorsal and relatively stout IIBr series. This curious form while giving an individual comatulid a very characteristic appearance, seems to be nothing more than the result of somewhat abnormal development. Individuals of this nature are not infrequent in *Heterometra reynaudi* at Ceylon.

In 1894 Prof. F. Jeffrey Bell described *Antedon inopinata* from the Macclesfield Bank. This new species he placed in Carpenter's *Granulifera* group, which included species of Thalassometridae and Charitometridae with the IIBr series 4(3+4) showing not the slightest resemblance to any species of *Himerometra*, which would fall in Carpenter's *Savignyi* group.

In 1895 Prof. René Koehler recorded and gave notes upon a specimen, identified as *Antedon crassispina*, from the Sunda Islands.

In my revision of the genus *Antedon* published in 1907, I placed *crassipinna* and *kraepelini* under the new genus *Himerometra*, of which the former was made the genotype. I was unable to place Bell's *inopinata* on the basis of Bell's description.

In a revision of the crinoid genus *Comatula* published on February 29, 1908, I placed Carpenter's *Actinometra robustipinna* in the genus *Comaster*.

In a paper published on August 25, 1908, I said of *Antedon inopinata* that it was described in Dr. P. H. Carpenter's *Granulifera* group, but it evidently belongs to the *Savignii* group; I remarked further that the species is not recognizable from the description.

In another revision of the species of Comasteridae published on October 30, 1908, *Actinometra robustipinna* was placed in the genus *Phanogenia*.

On December 23, 1908, I briefly diagnosed a new species from *Albatross* station 5165 in the Philippines which I called *Himerometra robustipinna*.

Having in 1910 examined at Leyden the type specimen of Carpenter's *Actinometra robustipinna*, I said in 1911, under the heading *Himerometra* sp., that this specimen proves to be an example of a typical species of *Himerometra*, and appears to represent the species, common at Singapore, to which I had referred (in 1909) as *Himerometra crassipinna* (in reality *H. martensi*), but that the identification cannot be considered certain because of the absence of the cirri and of most of the pinnule tips.

In 1912, having examined the type specimen of Hartlaub's *Antedon kraepelini* at Hamburg in 1910, I said, under the heading *Himerometra* sp., that this appears to be a small specimen of *Himerometra robustipinna* (of A. H. Clark, 1908) with which it agrees in the absence of a thickening or eversion of the distal edges of the segments of the enlarged proximal pinnules, but the lack of pinnule tips and of the cirri prevent accurate determination.

In my monograph on the crinoids of the Indian Ocean published in 1912, having found that Carpenter's *Actinometra robustipinna* is in reality a species of *Himerometra*, I renamed the species described by myself in 1908 as *Himerometra robustipinna*, calling it *Himerometra pulcher*. I gave *Himerometra inopinata* as a good species and included a description of it drawn up from the type specimen, which I had examined in the British Museum in 1910. *Actinometra robustipinna* of Carpenter I placed as a doubtful synonym under *H. crassipinna*, and I also discussed it under the heading *Himerometra*, sp. *Himerometra kraepelini* was given as a valid species without comment.

At this time the genus *Himerometra* was in a chaotic condition, so a detailed revision of the included forms was undertaken, which was published on November 25, 1913. In this revision *Himerometra robustipinna* (P. H. Carpenter) was considered as including *Actinometra robustipinna* P. H. Carpenter, 1881; *Antedon kraepelini* Hartlaub, 1890; *Antedon crassipinna* Hartlaub, 1890 (except the specimen from Cochinchina, which is referred to *H. magnipinna*); *Antedon inopinata* Bell, 1894;

Himerometra robustipinna A. H. Clark, 1908; and *Himerometra pulcher* A. H. Clark, 1912 (new name for the preceding).

In my notes on the recent crinoids in the British Museum published in 1913, under the heading *Himerometra robustipinna* (P. H. Carpenter) I said of the type of Bell's *Antedon inopinata* that the centrodorsal resembles that of the other species in the genus *Himerometra*.

Dr. August Reichensperger in 1913 described two specimens from Ceylon, which he referred to *Himerometra kraepelini*. He remarked that from the fragmentary description of *Himerometra robustipinna* published by me in 1908 it is to be concluded that the latter is unquestionably nothing else than *kraepelini*, of which form the lower pinnules are exceedingly characteristic. The name *pulcher*, suggested by me in 1912 to replace *robustipinna* of 1908, he said must also be placed in the synonymy of *kraepelini*.

In a key to the species of *Himerometra* published in the report on the unstalked crinoids collected by the *Siboga* in 1918 *robustipinna* was said, in a footnote, to include the *H. kraepelini* and *H. crassipinna* of Reichensperger.

In 1926 Dr. Hubert Lyman Clark recorded two specimens from the Great Barrier Reef, Queensland, thus considerably extending the known range of the species.

HIMEROMETRA MARTENSI (Hartlaub)

Plate 17, Figures 64, 65; Plate 18, Figures 66, 67; Plate 19, Figures 72–75

[See also vol. 1, pt. 1, figs. 10, 11 (nomenclature of centrodorsal and radial pentagon), p. 65; fig. 254 (centrodorsal), p. 253; fig. 338 (cirrus), p. 285; fig. 469 (centrodorsal), p. 359; pt. 2, figs. 41, 42 (radial pentagon), p. 26; fig. 123 (arm base), p. 79; fig. 326 (proximal pinnules), p. 227; fig. 347 (distal pinnules), p. 229; figs. 442, 443 (pinnule tip), p. 261; fig. 713 (disk), p. 346.]

Antedon martensi Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 182 (description; Singapore); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 18 (in key), p. 21 (detailed description and comparisons; Singapore), pl. 1, figs. 3, 6.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 383 (identified as *Himerometra crassipinna*); Crinoids of the Indian Ocean, 1912, p. 36 (identified as *Heterometra martensi*).

Himerometra martensi A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. Biol. Soc. Washington, vol. 22, 1908, p. 7 (listed); Proc. U. S. Nat. Mus., vol. 46, 1913, p. 285 (in key), p. 286 (synonymy; range); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 25 (Pulau Obin, Singapore); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 74 (in key; range); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 1, figs. 2, 3 (radials and centrodorsal).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 88 (articulations), p. 92 (pinnule articulations).—A. H. Clark, Proc. Biol. Soc. Washington, vol. 47, p. 9, 1934 (Singapore).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 27, 28, 30, 40.

Himerometra crassipinna A. H. Clark, Smithsonian Misc. Coll., vol. 50. 1907, p. 356 (in part; listed); Bull. Mus. Comp. Zool., vol. 51, 1908, p. 243 (relation to *H. persica*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 319 (specimen erroneously labeled "Japan"); Smithsonian Misc. Coll., vol. 52, 1908, p. 212 (compared with *H. bartschi*), p. 213 (compared with *H. robustipinna*), p. 214 (compared with *H. magnipinna*); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (in part; listed); Vid. Medd. Nat. Foren. København, 1909, p. 119 (ecology), p. 155 (Singapore; notes), p. 193 (collected at Singapore by Svend Gad); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 383 (*Antedon martensi* is this species [error]), p. 394 (British North Borneo; resembles others from Singapore; Singapore; type of *martensi* agrees with others at hand from Singapore); Crinoids of the Indian Ocean, 1912, p. 116 (records from Singapore and Pulau Ubin).

Heterometra martensi A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 36, 127 (Hartlaub's specimen from Singapore only).

Craspedometra martensi Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnostic features.—The enlarged proximal pinnules are very stout and taper rapidly to the tip; in fully developed individuals they are composed of about 20 segments the distal ends of which project abruptly beyond, but do not overlap, the bases of the segments succeeding and are armed with very numerous fine spines, which in large specimens may be confined to the outer segments; the distal ends of the proximal brachials are very strongly produced and everted so that the arm bases are very rough. There are 28–43 (usually 30–34) arms, which are 70–124 (usually 90–110) mm. long.

Description.—The centrodorsal is thick discoidal with the bare polar area rather small and concave, bearing 35–40 cirrus sockets in about three irregular and closely set rows about its margin, the distalmost cirrus sockets encroaching somewhat on the dorsal polar area.

The cirri are XV–XXXV, 28–40 (usually about 30), 23–37 (usually about 30) mm. long, large and stout. The segments are all somewhat broader than long and those in the distal half of the cirri bear small dorsal spines.

The radials are only very slightly, if at all, visible. The IBr_1 are short and are partially united laterally. The IBr_2 (axillaries) are short, pentagonal, dorsally rounded, and widely free laterally. The IBr series are 4(3+4), occasionally 2. The IIIBr series are commonly 2 interiorly and 4(3+4) exteriorly, but this is by no means an invariable rule. When less than the full number of IIIBr series is developed on a postradial series it is the outer ones that are lacking; in small specimens only the two inner may be present. The elements of the division series have a peculiar swollen appearance; while this feature occurs in all the species of *Himerometra* it is especially noticeable in this form.

The arms are 28–43 (usually 30–40) in number and are 70–124 (usually 90–110) mm. in length. The brachials are very uniform and short, discoidal, the first five or six being somewhat longer in proportion than the others, which are very short. All the brachials have overlapping and slightly everted distal edges, which give the arms a very rough appearance.

Syzygies occur between brachials 3+4, again from between brachials 23+24 to between brachials 31+32, and distally at intervals of 13 to 16 muscular articulations.

The pinnules on the division series and P_1 are enormously thickened, slightly recurved, and hornlike, with about 20 short cylindrical segments which are about as long as broad. The distal ends of the segments are markedly broader than the bases of the segments following so that the profile of the pinnules shows a series of abrupt steps; they are usually abundantly armed with fine spines, though in large individuals they may be simply roughened except in the distal portion of the pinnules. P_D is about 20 mm. long, and the pinnules succeeding decrease in length to P_1, which is about 16 mm. long. The pinnules of the inner arms are somewhat smaller than those of the outer. The following pinnules are slender, decreasing in length to about P_5, then gradually increasing again, reaching a length of 10 mm. distally.

The color in alcohol is flesh color; no markings are recorded on any specimen.

Notes.—The type specimen was described by Hartlaub as follows: The centrodorsal is a thick disk with a flat bare dorsal pole, bearing cirri in two rows. The cirri are about XX, about 25, about 18 mm. long, and stout. The distal border of the segments is somewhat produced. The distal segments bear small spines, and the antepenultimate carries a stout opposing spine. The radials are partially visible laterally. The IBr_1 are entirely free laterally. The IBr_2 (axillaries) are pentagonal. The IIBr series are 4(3+4), and the IIIBr series are 2. The two ossicles following the IBr axillaries are partially united interiorly. The articulations are smooth. The IBr axillaries and immediately following ossicles have no lateral processes. The arms are apparently not more than 30 in number and are all broken. The brachials are short and overlapping with, except for the first two, strongly produced distal ends. The first syzygy is between brachials 3+4, and the next is about the twenty-fourth brachial. P_D is very stout and stiff, about 9 mm. in length, with 12–15 segments, of which the three basal are very large and those following decrease abruptly in size. P_1 is smaller and less stiff, although its basal segments are also very large. P_2 is much smaller, scarcely 4 mm. long, and beyond the basal segments rapidly becomes slender. The disk is 10 mm. in diameter, and is deeply incised. Sacculi are rather sparsely distributed on the pinnules. The color of the skeleton is gray-brown.

Hartlaub remarked that this specimen is unfortunately much broken. As shown in his figure the arms are all broken away at the articulation between the first and second brachials except for a single stump including 15 brachials. But, as Hartlaub says, the characters by which the species represented differs from other species are well shown. Especially characteristic are the massive lower pinnules, quite unique in form, and the strongly produced distal ends of the fourth and following brachials. He said that this species is nearest *Antedon kraepelini* (=*Himerometra robustipinna*) from Akyab with which, as also with others, it agrees in the position of the second brachial syzygy.

As it is shown on the plate Hartlaub's figure of P_D (pl. 1, fig. 6) is deceptive, for the shading gives the impression that the pinnule and the portion of the arm shown are sharply flattened laterally more or less like P_1 and the adjacent portion of the arm base in a species of *Thalassometra*. But if the figure is viewed upside down it gives the proper impression of convexity.

I have examined the type specimen of Hartlaub's *Antedon martensi*. It is a rather small and badly broken specimen, but it agrees in every particular with the specimens in the Copenhagen Museum, with which it was compared directly.

Some of the specimens collected by Svend Gad at Singapore present the following characters:

June 15, 1905; one has 31 arms 70 mm. long, and the other has 36 arms 70 mm. long.

June 16, 1907; the five specimens have 29–43 arms 65–80 mm. long.

November 27, 1907; three specimens with 27 arms 70 mm. long, 37 arms 80 mm. long, and 38 arms 70 mm. long. These specimens are typical of the whole series. The centrodorsal has a broad, slightly concave, dorsal pole. The longest cirri have about 30 segments, sometimes rather less, but more commonly rather more. The IIBr series are always present, and are almost invariably 4(3+4). The exterior IIIBr series are 4(3+4) and the interior are 2; when a deficiency in the IIIBr series occurs the exterior IIIBr series are usually lacking, so that there is a tendency toward a IIIBr arrangement of 1, 2, 2, 1. The IVBr series, when present, are 2, and are developed externally in reference to the IIBr series. The overlapping of the distal edges of the brachials begins at the second and is strongly developed. P_D is about 13 mm. long, very stout, the component segments having prominently spinous distal ends.

January 24, 1910; of the nine specimens the largest has 43 arms 100 mm. long. A very small specimen has 11 arms 35 mm. long. On the arms arising directly from a IBr axillary P_1 is 6 mm. long, greatly enlarged as in fully grown individuals, with 12 or 13 segments. P_a is very much smaller and more slender, and P_2 is smaller and slenderer still. P_3 and the following pinnules are very small and short.

These specimens collected by Mr. Gad are all pale flesh colored or light purplish, with the perisome brown, as are all the others I have seen from the same locality. They are practically uniform in size and are all much smaller than those in the U. S. National Museum, the Museum of Comparative Zoology, the Yale University Museum, and the collection of Prof. Robert T. Jackson of Harvard University, all of which were obtained from Ward's Natural Science Establishment. But except for the smaller size and the slightly inferior number of cirrus segments (probably correlated with the lesser size) I am unable to detect any difference.

The description of this species was drawn up from a study of 25 specimens from Singapore in the collections of the U. S. National Museum (2), the Boston Society of Natural History (19), the Museum of Comparative Zoology (1), the Yale University Museum (2), and Prof. Robert Tracy Jackson (1, now in the collection of the Museum of Comparative Zoology), all of which were secured from Ward's Natural Science Establishment. These show the following characters:

One of the specimens in the U. S. National Museum has 40 arms 100 mm. long, and XXXV stout cirri 30 mm. long. The IIBr series are all 4(3+4). Of the IIIBr series 8 are 4(3+4) and 10 are 2, the latter most often developed interiorly. The post-radial series are rounded and well separated. P_2 resembles P_1 in character but is only about half as long.

The other specimen in the U. S. National Museum has 35 arms, mostly arranged in 1, 2, 2, 1 order; the arms are 110 mm. long. The cirri are 30 mm. long and are composed of 30 segments. The inner IIIBr series are usually 2; IIIBr series are usually not present on the outer side of the IIBr series, but if present they are 4(3+4).

The specimen in the Museum of Comparative Zoology (dry) has 31 arms 110 mm. long. The cirri are XXX, 30, 30 mm. long. The IIBr series are all 4(3+4). The inner IIIBr series are all present, and all are 2; there is a single exterior IIIBr series which is 4(3+4).

Professor Jackson's specimen (now in the Museum of Comparative Zoology) has about 40 arms 110 mm. long. The cirri are XXXIII, 37–40, 37 mm. long. On the anterior postradial series both the IIBr series are 2, and one of the lateral postradial series has one IIBr series 2 and the other 4(3+4). All the other IIBr series are 4(3+4). On the postradial series with both IIBr series 2 all four of the IIIBr series are 4(3+4). On the postradial series with one IIBr series 2 and the other 4(3+4) the IIIBr series are 4(3+4), 2, 2, 0. On the remaining postradial series the IIIBr series are as follows: 0, 2, 2, 0; 4(3+4), 2, 2, 0; 0, 2, 2, 4(3+4). The IVBr series following IIIBr 2 series are 4(3+4), and those following IIIBr 4(3+4) series are 2. The postradial series are well rounded and are widely free laterally.

Fifteen of the specimens in the Boston Society of Natural History show the following features:

1. All the IIBr series are 4(3+4). The three remaining IIIBr series are 2.

2. There are 34 arms 97 mm. long. The cirri have 27–30 segments and are 23 mm. long. The IIBr series are all 4(3+4). On the various postradial series the IIIBr series are as follows: 0, 2, 4(3+4), 4(3+4); 0, 2, 2, 4(3+4); 0, 2, 2, 0; 4(3+4) 2, 2, 4(3+4); 0, 2, 2, 0.

3. There are 31 arms 97 mm. long. The cirri are XV, 32, 37 mm. long. All the inner IIIBr series are developed, and all are 2; there is a single exterior IIIBr 4(3+4) series.

4. The cirri have 30 segments. All the IIBr series are 4(3+4). The five remaining IIIBr series are 2. There is a single IVBr 2 series.

5. All the IIBr series are 4(3+4). On three postradial series the IIIBr series are 0, 2, 2, 0, and on the other two they are 0, 2, 2, 4(3+4).

6. The arms are 122 mm. long, and the cirri have 30 segments. All the IIBr series are 4(3+4). On three postradial series the IIIBr series are 0, 2, 2, 0, and on the other two they are 4(3+4), 2, 2, 0 and 0, 4(3+4), 4(3+4), 4(3+4).

7. The cirri have 30–33 segments. The IIBr series are all 4 (3+4). On three of the postradial series the IIIBr series are 0, 2, 2, 0, and on another they are 4 (3+4), 2, 2, 0. There is a single IVBr 4 (3+4) series present.

8. There are 28–30 cirrus segments. The IIBr series on the left anterior and left posterior postradial series are 2, all the others being 4 (3+4). On the left anterior postradial series there are no IIIBr series; on the left posterior postradial series the IIIBr series are 4 (3+4), 0, 0, 0; on the three remaining postradial series the IIIBr series are 4 (3+4), 0, 2, 0; 0, 4 (3+4), 2, 0; and 2, 0, 0, 2.

9. There are 31 cirrus segments. All the IIBr series are 4 (3+4). On the several postradial series the IIIBr series are: 4 (3+4), 2, 4 (3+4), 0; 0, 2, 2, 4 (3+4); 4 (3+4), 2, 2, 0; 0, 2, 2, 0; and 4 (3+4), 2, 2, 4 (3+4). There are two IVBr 4 (3+4) series.

10. In a small broken specimen all the IIBr series are 4 (3+4). All the IIIBr series, which are present on the remaining postradial series only internally, are 2. The IVBr series are 4 (3+4).

11. The IIBr series are all 4 (3+4). There is only one complete postradial series on which the IIIBr series are 4 (3+4), 2, 2, 4 (3+4). Two other postradial series have IIIBr 2 series remaining.

12. There are 28–30 cirrus segments. All the IIBr series are 4 (3+4). On two postradial series the IIIBr series are 0, 2, 2, 0, and on two others they are 0, 2, 2, 4 (3+4); on the fifth they are 0, 2, 2, 4 (3+4) with, on the second, an inner IVBr 4 (3+4) series.

13. There are 30 cirrus segments, of which the outer bear dorsal spines which are rather more prominent than usual. One of the IIBr series is 2, the other nine being 4 (3+4). On two postradial series the IIIBr series are 0, 2, 2, 0; on the other three they are 0, 0, 0, 0; 0, 0, 2, 0; and 2, 2, 2, 0.

14. The arms are 124 mm. long. The IIBr series are all 4 (3+4). On two postradial series the IIIBr series are all 4 (3+4); on two more they are 0, 2, 2, 0; and on the fifth they are 4 (3+4), 2, 2, 0.

15. There are 30 arms, all the inner IIIBr series being present. All the IIBr series and also all the IIIBr series are 4 (3+4).

The specimen from Pulau Obin, Singapore, in the British Museum resembles those from Singapore in the U. S. National and Copenhagen Museums. The specimen from British North Borneo resembles those from Singapore, although the proximal cirrus segments are a trifle shorter.

Localities.—Singapore, Straits Settlements; Prof. Ed. von Martens [Hartlaub, 1890, 1891; A. H. Clark, 1912] (1, Berl. M., 5373).

Singapore; Svend Gad [A. H. Clark, 1909] (27, U. S. N. M., 36136, 36176, E. 1080; C. M.).

Singapore [A. H. Clark, 1909] (18, B. S.).

Singapore [A. H. Clark, 1909] (1, R. T. J. [now M. C. Z.]).

Singapore; from Ward's Natural Science Establishment, through Dr. F. A. Lucas [A. H. Clark, 1909] (2, U. S. N. M., 35968).

Singapore [A. H. Clark, 1934] (1, Raffles Mus.).

Singapore (2, M. C. Z., 59, 289).

Singapore (1, Y. M.).

Pulau Obin, Singapore [A. H. Clark, 1913] (1, B. M.).

British North Borneo; Herr Pagel [A. H. Clark, 1912] (1, Berl. M., 4744).

Erroneous locality.—Japan [A. H. Clark, 1908] (1, B. S.).

Geographical range.—Only known from Singapore and British North Borneo.

Bathymetrical range.—Littoral; all the known specimens were taken in shore collecting.

History.—Dr. Clemens Hartlaub described this species, as *Antedon martensi*, in 1890 from a small and much mutilated individual which had been collected by Prof. Ed. von Martens at Singapore. He redescribed and figured it in 1891.

It was referred to the new genus *Himerometra* by me when that genus was created in 1907.

In 1908, under the name *Himerometra crassipinna*, I mentioned a specimen that I had seen labeled, probably erroneously, "Japan."

In 1909 in a revision of the family Himerometridae, *martensi* was retained in *Himerometra*.

Later in 1909 in my account of the comatulids in the Copenhagen Museum, I identified as *martensi*, placing the species in the genus *Heterometra*, a specimen from Singapore which appears really to represent *H. bartschi*. At the same time I recorded, as *Himerometra crassipinna*, and gave notes upon 16 specimens from Singapore, which are in reality *H. martensi*. In discussing these I mentioned other larger specimens from Singapore that I had examined in the U. S. National Museum, in the Boston Society of Natural History, and in the collection of Prof. Robert T. Jackson at Harvard University.

In 1912, in a paper on the crinoids in the Berlin Museum, under the heading *Himerometra crassipinna*, I gave notes upon Hartlaub's type specimen and recorded and gave notes on another from British North Borneo.

In my monograph of the crinoids of the Indian Ocean published in 1912, following my report on the crinoids of the Copenhagen Museum, I placed *martensi* in the genus *Heterometra* and gave the locality as Singapore. I included what was really *martensi* under *Himerometra crassipinna*, which is the species found at two of the localities given.—Singapore and Pulau Ubin.

In 1913, in a revision of the genus *Himerometra*, I gave in a key to the included species the differential characters of *H. martensi*. A complete synonymy of the species was given, and the range was correctly noted as Singapore, Pulau Ubin, and British North Borneo.

In the *Siboga* report published in 1918 *martensi* was included in the key to the species of *Himerometra*, and the correct range was given.

In 1924 Dr. Torsten Gislén discussed the articulations of this species on the basis of material from Singapore.

In 1934 I said that this species has long been known to be common at Singapore.

HIMEROMETRA BARTSCHI A. H. Clark

Plate 14, Figures 52, 53; Plate 16, Figures 57–59

Himerometra bartschi A. H. Clark, Smithsonian Misc. Coll., vol. 52, 1908, p. 212 (description; *Albatross* stations 5146; also 5147), p. 214 (comparison with *H. magnipinna*); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Crinoids of the Indian Ocean, 1912, p. 114 (synonymy; locality); Proc. U. S. Nat. Mus., vol. 46, 1913, p. 285 (in key), p. 288 (synonymy; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 73 (in key; range), p. 75 (references; notes; station 96), p. 272 (listed).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 41, 48.—A. H. Clark, Temminckia, vol. 1, 1936, p. 302 (Amboina, 0–2 meters); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 103.

Himerometra persica A. H. Clark, Smithsonian Misc. Coll., vol. 52, 1908, p. 214 (*Albatross* station 5163; also Philippine Islands with no definite data); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (in part; listed); Crinoids of the Indian Ocean, 1912, p. 16 (in part; records from Philippine Islands).

Heterometra martensi A. H. Clark, Vid. Medd. Nat. Foren. København, 1909, pp. 164, 165 (Singapore), p. 193 (collected at Singapore by Svend Gad); Crinoids of the Indian Ocean, 1912, p. 127 (Clark's record from Singapore).

Diagnostic features.—The proximal pinnules are slender, flagellate distally, and very long, composed of 37-40 perfectly smooth segments most or all of which are longer than broad, with a few of the earlier narrowly but prominently carinate; the earlier segments of the following pinnules are very strongly carinate. The cirri have 35–43 segments, of which those in the distal half bear prominent dorsal spines. The 37–61 arms are 120–150 mm. long.

Description.—The centrodorsal is thick discoidal with a rather strongly concave polar area. The cirrus sockets are arranged in two and a partial third crowded and more or less alternating rows.

The cirri are XXX, 41–43, moderately stout, rather more than one-third the length of the arms, 45 mm. long. The first five segments are about twice as broad as long and those following gradually increase in length to the ninth or tenth, which is about as long as broad; after about the sixteenth they gradually decrease in length, the terminal segments being about twice as broad as long. After the seventeenth segment small but prominent dorsal spines are developed. The opposing spine is centrally situated, rather slender, in height reaching to about one-half the width of the penultimate segment. The terminal claw is considerably longer than the penultimate segment, and is slender and moderately curved.

The distal ends of the radials are approximately even with the rim of the centrodorsal. The IBr_1 are short, and are laterally united for their entire length. The IIBr series are 4 (3+4). The IIIBr series are 4 (3+4) exteriorly and 2 interiorly. The IVBr series, which are developed only on the inner side of the inner IIIBr series from each IIBr series, are 4 (3+4). Each IIBr series divides once exteriorly and twice interiorly. The division series resemble those of *H. martensi.*

The 51 arms of the type specimen are 120 mm. in length and resemble those of *H. martensi.*

P_D and P_P are 25 mm. long, very stout basally but tapering gradually to a slender and delicate tip, with about 40 segments most of which are about as long as broad. P_1 is 15–17 mm. long, proportionately slenderer than the preceding pinnules, with about 32 segments, which are slightly longer than broad, the first two slightly carinate. P_2 is smaller and slenderer, 13 mm. long, with 30 segments of which the first is short, the next three or four are about as long as broad, and the remainder are slightly longer than broad; the second, third, and fourth segments are somewhat carinate. P_3 is 8 mm. long, small, and weak, with about 20 segments, of which those in the proximal half are about as long as broad and those in the distal half are slightly longer than broad; the second-sixth are rather strongly carinate. The succeeding pinnules decrease rapidly in length, the fifth and following being 5 mm. long, then slowly increase again, reaching a length of 9 mm. distally.

Notes.—In the specimen from *Siboga* station 96 the cirri are rather stout, 30 mm. long, with 37–38 segments, of which the longest proximal are from half again to twice as broad as long; there is very little difference between the proximal and distal segments; from the nineteenth or twentieth segment onward prominent dorsal tubercles or short blunt dorsal spines are developed. The 61 arms are 120 mm. long. Four of the postradial series bear 12 arms each, and the fifth bears 13 arms. Each IIBr series bears externally a IIIBr 4(3+4) series and internally a IIIBr 2 series, which carries two IVBr 4(3+4) series.

P_D is 23 mm. long, with 37 segments, very stout basally but tapering evenly to a slender and flagellate tip. The basal segments are twice as broad as long, those following gradually increasing in length and becoming about as long as broad on the twelfth and half again as long as broad in the delicate terminal portion. The pinnule is perfectly smooth, with no traces of eversion of the distal edges of the segments. P_P is 22 mm. long, with 36 segments and is only very slightly smaller than P_D. P_1 is similar to the two preceding pinnules but is somewhat smaller, 17 mm. long. P_2 is weak and slender, 8.5 mm. long, with 23 segments, of which the second-fifth have a prominent narrow carination the distal border of which is parallel to the longitudinal axis of the segments. P_3 is 6.5 mm. in length, resembling P_2 but very slightly smaller. P_4 is 5.5 mm. long, resembling P_3 but very slightly smaller; the second-fourth segments are carinate. From this point the amount of carination of the earlier segments of the pinnules decreases, though it is traceable to the end of the proximal fourth of the arm. This specimen differs from the type only in the slightly smaller size and in the slightly shorter proximal cirrus segments.

In the specimen from Singapore the cirri are XII 26–30, 20 mm. long, and rather slender; the segments have rather prominent ends. There are 17 arms 50 mm. long. Four IIBr series are developed of which three are 4(3+4) and one is 2. There are three IIIBr series, all on a single postradial series, two 4(3+4) following the IIBr 2 series, and one 2, developed internally. P_D (or P_1) is 9 mm. long with 21–22 segments, very stout basally but tapering evenly and becoming flagellate distally. P_2 is similar but is somewhat smaller. The following pinnules are small and weak.

In a specimen from the Danish Expedition to the Kei Islands station 19 the cirri are large and stout, XXV, 35–36, 35 mm. long. The longest segments are about one-third again as broad as long, or on some cirri nearly or even quite as long as broad. Dorsal processes begin to appear on from the eighth to the tenth segment, and after five or six become long and conspicuous triangular dorsal spines arising from the entire dorsal surface of the segment which are either erect or directed distally; frequently the tip of the spine is notched. The 47 arms are 150 mm. long. Of the 10 IIBr series present 7 are 4(3+4), one is 2, and 2 are 4, the two outer elements not being united by syzygy. On two postradial series the IIIBr series are 4(3+4) externally and 2 internally. On two other postradial series three of the IIIBr series are 4(3+4), one of the two internally developed being 2. On the fifth postradial series all the IIIBr series are 4(3+4). The IVBr series are all 4(3+4), and all are developed on the inner portion of a postradial series, next the midradial line.

P_D is 22 mm. long, with 40 segments, of which the first is about twice as broad as long, the second and third are slightly broader than long, and the remainder are about as long as broad. The pinnule is moderately stout at the base but tapers in the proximal third and in the outer half is slender and flagellate. The second-fourth segments have a low well-rounded inconspicuous keel in the middle of the dorsal side. P_P is 23 mm. long, with 40 segments, in some cases resembling P_D but usually somewhat stouter, and sometimes considerably stouter. The first five to eight segments have an obscure median elevation on the dorsal side and the second-eighth have the outer edge (toward the arm tip) produced into a thin narrow keel. P_1 is 15–17 mm. long with 31 segments, and resembles the preceding pinnules but is slenderer; the outer border of the second-eighth segments is produced into a narrow knifelike carination. P_2 is 11–12 mm. long, considerably slenderer than P_1 and is composed of 26 segments, of which the outermost are about twice as long as broad. The second-sixth have a more conspicuous carination of the outer edge than the corresponding segments of the preceding pinnules. P_3 is 8 mm. long, with 19 segments, and is considerably slenderer than P_2. As in P_2 the second-sixth segments are very strongly carinate. The following pinnules are smaller and shorter, with the third-sixth segments strongly carinate. This carination of the earlier pinnule segments remains conspicuous until about the middle of the arm and is indicated even on the second and third segments of the terminal pinnules.

Of the other specimens from the Danish Expedition to the Kei Islands station 19 one has 47 arms 140 mm. long and the cirri 40 mm. long with 35 segments, and another has 37 arms 140 mm. long.

In one of the specimens from Amboina there are 47 arms 140 mm. long, and the longest cirri are 50 mm. long, with 37–43 segments. The other specimen from Amboina has 42 arms 125 mm. long.

The specimen collected by the *Willebrord Snellius* at Amboina is a fine example with 55 arms 150 mm. long. P_C and P_P have 38–40 segments.

Localities.—*Albatross* station 5146; Sulu (Jolo) Archipelago, in the vicinity of Siasi; Sulade Island (E.) bearing N., 18° W., 3.4 miles distant (lat. 5° 46′ 40″ N., long. 120° 48′ 50″ E.); 44 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1908] (1, U.S.N.M., 25438 [type]).

Albatross station 5147; Sulu Archipelago, in the vicinity of Siasi; Sulade Island (E.) bearing N. 3° E., 8.4 miles distant (lat. 5° 41′ 40″ N., long. 120° 47′ 10″ E.); 38 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1908] (1, U.S.N.M., 35205).

Albatross station 5163; Sulu Archipelago, Tawi Tawi group; Observation Island bearing N. 79° W., 6.7 miles distant (lat. 4° 59′ 10″ N., long. 119° 51′ 00″ E.); 51 meters; February 24, 1908 [A. H. Clark, 1908] (1, U.S.N.M., 35096).

Siboga station 96; southeastern side of the Pearl Banks, Sulu Archipelago; 15 meters; lithothamnion bottom; June 27, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Albatross; Philippine Islands; 1907–'08 [A. H. Clark, 1908] (1, U.S.N.M., 35193).

Singapore; Svend Gad [A. H. Clark, 1909] (1, C.M.).

Amboina; pier; 0–2 meters; *Willebrord Snellius*, May 6, 1930 (1, L.M.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 19 (4).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Amboina; breakwater; about 1 meter; February 28, 1922 (2).

Geographical range.—From the Philippine Islands and Singapore south to Amboina and the Kei Islands.

Bathymetrical range.—From the shoreline down to 51 meters.

Remarks.—This form is probably only a large East Indian race of *H. persica* from the Persian Gulf.

History.—This species was originally described in 1908 from a specimen dredged by the *Albatross* at station 5146 in the Philippines. At the same time another specimen was recorded from station 5147, near the type locality. In the same paper *H. persica* was recorded from *Albatross* station 5163, and from the *Albatross* Philippine collections without further data.

In 1909 I recorded and described from Singapore, under the name of *Heterometra martensi*, a specimen that could only have been a young example of this species. I said that P_2 is similar to, but smaller than, P_D or P_1 and that these pinnules are flagellate distally. I remarked further that the proximal pinnules, though for the genus unique in their proportionate lengths, are of the type common to all species of *Heterometra*. Pinnules resembling those of the species of *Heterometra* with the first the longest are found only in *H. bartschi* and in *H. persica*.

In my monograph of the crinoids of the Indian Ocean published in 1912, I gave *H. persica* as occurring both in the Persian Gulf and in the Philippines, but in the following year in a revision of the genus *Himerometra* the specimens from the Philippines recorded in 1908 and 1912 as *H. persica* were redetermined as *H. bartschi*.

In 1918 I recorded and gave notes upon a specimen from *Siboga* station 96, near the type locality.

HIMEROMETRA PERSICA A. H. Clark

PLATE 19, FIGURES 70, 71

[See also vol. 1, pt. 1, fig. 318 (tip of cirrus), p. 273; fig. 339 (cirrus), p. 285; pt. 2, fig. 272 (arm and pinnules), p. 207; fig. 444 (pinnule tip), p. 261.]

Himerometra persica A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed; *nomen nudum*); Bull. Mus. Comp. Zool., vol. 51, 1908, p. 243 (description; Persian Gulf); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Amer. Nat., vol. 43, 1909, p. 256 (absent from the Red Sea; Persian Gulf to Philippines [specimens from last really *H. bartschi*]); Crinoids of the Indian Ocean, 1912, p. 11 (occurs both east and west of Ceylon), p. 21 (range covers that of all the other species, and extends farther west), p. 116 (synonymy; range [specimens from the Philippines are *H. bartschi*]); Proc. U. S. Nat. Mus., vol. 46, 1913, p. 285 (in key), p. 289 (annotated synonymy; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 73 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 23, 46, 48, 49, 52.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 99 (range), p. 103.

Diagnostic features.—The proximal pinnules are slender, flagellate distally, and very long, composed of perfectly smooth segments most or all of which are longer than broad, with a few of the earlier narrowly but prominently carinate; the earlier segments of the following pinnules are very strongly carinate. The cirri have 35 segments of which those in the outer half have prominent dorsal spines. The 20–25 arms are about 150 mm. long.

Description.—The centrodorsal is low hemispherical with a large bare polar area. The cirri are about XXV, 35, 27 mm. long. Most of the cirrus segments are slightly longer than broad, the distal about as long as broad; the last 16–18 bear sharp dorsal spines.

The radials are just visible beyond the rim of the centrodorsal. The IBr_1 are trapezoidal, about three times as broad as long. The IBr_2 (axillaries) are pentagonal, about half again as broad as long, with a sharp distal angle. The IIBr series are 4(3+4) or 2. The division series are strongly rounded dorsally and widely free laterally.

The 20–25 arms are 150 mm. in length. The first eight brachials are roughly oblong, those following becoming wedge-shaped, much broader than long, and oblong toward the end of the arms.

Syzygies occur between brachials 3+4, again in the vicinity of the seventeenth brachial, and distally at intervals of 6 to 13 (usually about 8) muscular articulations.

P_D is 13 mm. long, very slender and flagellate, with 36 segments, all of which are somewhat longer than broad, but not much so; the first four segments are the broadest and are slightly carinate. P_1 is similar but longer, 16 mm. in length, and stouter basally; the five or six basal segments are sharply carinate, and from this point the pinnule tapers gradually to the long and delicate flagellate tip. P_2 resembles P_1 and is of the same length. The next few pinnules decrease rapidly in length, and those following increase somewhat distally, but do not become very long. The carination of the basal pinnule segments becomes less and less marked distally and is not noticeable after P_6; it is at its maximum on P_1 and P_2.

The color in alcohol is dull brown, the skeleton somewhat lighter.

Locality.—Persian Gulf; F. W. Townsend [A. H. Clark, 1908] (2, M.C.Z., 291).

Remarks.—This species is as yet known only from the two specimens described in 1908. It is very distinct from all the others in the genus with the exception of *H. bartschi*, which will probably prove to be simply its Malayan variety.

Genus CRASPEDOMETRA A. H. Clark

Antedon (part) P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 509, and following authors.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Craspedometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 8 (diagnosis; genotype *Antedon acuticirra* P. H. Carpenter, 1882), p. 175 (referred to the Himerometrinae); Mem. Australian Mus., vol. 4, 1911, pp. 731, 732 (in keys), p. 735 (1 species in Australia), p. 763 (original reference; characters; range); Crinoids of the Indian Ocean, 1912, p. 10 (does not extend beyond Hongkong; absent from Japan; reason), p. 11 (occurs both east and west of Ceylon), p. 12 (represented in Red Sea region and in southeast African region), p. 21 (distribution in detail), p. 56 (in key), p. 117 (original reference; type).—F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Pap. 90–L, 1915, p. 195 (inorganic constituents of the skeleton); Prof. Pap. 102, 1917, pp. 23ff. (same).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 72 (in key; range).—F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Pap. 124, 1922, p. 20 (inorganic constituents of the skeleton).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 44.

Diagnosis.—A genus of Himerometridae in which the cirri are long, with 40–60 segments, nearly straight or slightly curved, tapering gradually from a stout proximal portion to a sharply pointed tip, with the distal segments much longer than broad and without dorsal processes; there is no opposing spine, and the terminal claw is nearly straight. P_D is shorter and more slender than P_1, which in turn is shorter and more slender than P_2. The IIIBr series are usually developed only on the inner side of the IIBr series, and are 2; if they are developed both interiorly and exteriorly they are commonly 2 interiorly and 4(3+4) exteriorly.

Geographical range.—From the Gulf of Martaban and the Andaman Islands to Amboina, and northward to the Philippine Islands.

Bathymetrical range.—Littoral and sublittoral; the only recorded depth is 33 meters.

Remarks.—While the single species included in this genus is, because of the long, nearly straight, gradually tapering, sharp pointed and smooth cirri, strikingly different in its general appearance from the species of *Heterometra* it scarcely deserves to be separated from them. It agrees with them in all its other characters. Moreover, slight dorsal tubercles are present in one of the known specimens on the outer cirrus segments, while in some of the species of *Heterometra* these are so slight as to be barely noticeable.

History.—The single species now included in this genus was originally described in 1882 in the genus *Antedon* under four different names. With my first revision of the old genus *Antedon* in 1907 this species was placed in the new genus *Himerometra*. In 1909 the genus *Craspedometra* was established with *Antedon acuticirra* P. H. Carpenter, 1882, as the genotype, and the nominal species listed as referable to it were *Craspedometra acuticirra*, *C. australis*, *C. bipartipinna*, and *C. ludovici*, all of which represent in reality the same form.

In 1911 I described two new species under the names *Craspedometra ater* and *C. madagascarensis*, and in 1912 in my monograph of the crinoids of the Indian Ocean I listed these, gave the name *Craspedometra amboinae* to the specimens from Amboina referred by Hartlaub in 1891 to *Antedon ludovici*, and referred Carpenter's *Antedon anceps* to the genus *Craspedometra*. In 1913 Dr. A. Reichensperger used the names *Craspedometra amboinae* and *C. anceps* and suggested that the specimen he referred to *C. anceps* might represent a new species, in which event it could be called *C. aruensis.*

Recognizing the rather obvious fact that *Craspedometra*, including *acuticirra*, *ater*, *madagascarensis*, and *amboinae*, was quite impossible of definition as distinct from *Heterometra*, in 1918 I included it in a key to the genera of the Himerometridae with structural characters and a geographical range applying only to *acuticirra*, although it was not specifically stated that this was the only species now included.

CRASPEDOMETRA ACUTICIRRA (P. H. Carpenter)

PLATE 13, FIGURES 50, 51; PLATE 20, FIGURES 76–81

[See also vol. 1, pt. 1, fig. 85 (side view), p. 139; fig. 255 (centrodorsal), p. 253; fig. 471 (centrodorsal), p. 361; pt. 2, figs. 43, 44 (radial pentagon), p. 26; figs. 141, 142 (arm base), p. 83; figs. 449, 450 (pinnule tip), p. 261; figs. 716, 717 (disks), p. 346.]

Antedon acuticirra P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 509 (description; locality unknown); Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 55, 116, 253, 366, 380.—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 29 (synonym of *A. ludovici*), p. 32 (characters of the type specimen).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 455 (listed); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity); Crinoids of the Indian Ocean, 1912, p. 35 (same).

Antedon ludovici P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 510 (description; Hongkong); Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 55, 253, 366, 380.—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 19 (in key), p. 29 (includes *A. acuticirra* and ?*A. biportipinna* [specimens described from Amboina are *Heterometra amboinae*]), p. 30 (notes on the type specimen).—DÖDERLEIN, Denkschr. med.-nat. Ges. Jena, vol. 8, pt. 5, 1898, p. 477 (Amboina).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 481 (listed); Mem. Australian Mus., vol. 4, 1911, p. 720 (of Döderlein, 1898 = *Craspedometra acuticirra*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (of P. H. Carpenter, 1882 = *Craspedometra acuticirra*); Crinoids of the Indian Ocean, 1912, p. 35 (of P. H. Carpenter, 1888 = *C. acuticirra* + *C. amboinae* [error]), p. 37 (of Hartlaub, 1891 = ? [*C. amboinae* should have been given here]), p. 39 (of Döderlein, 1898 = *C. acuticirra*).

Antedon australis P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 510 (in text under heading of *A. acuticirra;* Sydney, New South Wales; notes).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 459 (listed); Vid. Medd. Nat. Foren. København, 1909, p. 159 (synonym of *acuticirra;* description of the type); Mem. Australian Mus., vol. 4, 1911, p. 713 (history; identity).

Antedon biportipinna P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 512 (description; Hongkong); Proc. Zool. Soc. London, 1882 (1883), p. 747 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 55, 253, 366, 380.—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 19 (in key), p. 29 (?synonym of *A. ludovici*), p. 31 (notes on the type specimen).—MINCKERT, Archiv für Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 228 (regeneration).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 462 (listed); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (= *C. acuticirra*); Crinoids of the Indian Ocean, 1912, p. 35 (same).

Himerometra ludovici A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Craspedometra acuticirra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 9 (listed); Vid. Medd. Nat. Foren. København, 1909, p. 159 (includes *A. australis;* description of the type specimen of *australis*), p. 161 (Singapore; description of a small specimen), p. 193 (collected at Singapore by Svend Gad); Proc. U. S. Nat. Mus., vol. 37, 1909, p. 31 (color of cirri compared with that of *C. aliena*, sp. nov.); A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 251 (Singapore; description of a specimen); Die Fauna Südwest Australiens, vol. 3, Lief. 13, 1911, p. 440 (East Indian species occurring south to Sydney), p. 443 (range on the east coast); Mem. Australian Mus., vol. 4, 1911, p. 713 (= *A. australis*), p. 722 (ranges south to Port Jackson or Sydney), p. 763 (synonymy; characters; Australian record; range); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (*acuticirra*, *ludovici*, *australis*, and *bipartipinna* all the same species), p. 19 (discussion and descriptions); Crinoids of the Indian Ocean, 1912, pp. 35, 39 (synonymy), p. 39 (synonymy; new records; descriptions), fig. 8, *a*, *b*, p. 118; Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range in eastern Asia).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 99 (comparison with *C. amboinae*), p. 100 (comparison with *C. anceps* [*aruensis* ?sp. n.]).—A. H. Clark, Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (Malayan species; range and its significance); Internat. Rev. gesamt. Hydrobiol. und Hydrogr. 1915, pp. 223 ff. (detailed account of distribution in Australia); Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 556 (Trotter Island); Treubia, vol. 14, livr. 2, 1933, p. 207 (55 specimens in collection), p. 208 (not included in *Siboga* collection), p. 211 (off Cape Jabung; near Deli; Malacca Strait; notes).—Th. Mortensen, Hong Kong Nat., Suppl., No. 3, 1934, p. 5 (Hongkong).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 27.

Craspedometra australis A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 9 (listed).

Craspedometra bipartipinna A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 9 (listed).

Craspedometra ludovici A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 9 (listed).

Diagnostic features.—The cirri are long, stout basally and gradually tapering to a sharp point distally, nearly straight or slightly curved, composed of 40–60 segments of which the distal are much longer than broad and are entirely smooth dorsally; there is no opposing spine and the terminal claw is nearly straight.

Description of a specimen labeled Sydney, N. S. W.—The centrodorsal is large, thick discoidal, with a broad flat polar area 5 mm. in diameter. The cirrus sockets are arranged in a single marginal row.

The cirri are XVI, 42–46, 45 mm. long, large and stout basally but gradually tapering, rather more rapidly in the distal portion, to a very slender sharp pointed tip. The first four or five segments are about two and one-half times as broad as long, and those following gradually increase in length, becoming about as long as broad at the tenth, then slightly longer than broad, and in the terminal 10 or 12 about twice as long as broad. The cirri are rounded dorsally with no dorsal spines or carination. The terminal claw is long, about as long as the penultimate segment, and nearly straight.

The anterolateral corners of the radials are barely visible in the interradial angles of the calyx. The IBr_1 are very short, six or eight times as broad as long, rather longer laterally than in the midradial line, almost entirely united laterally. The IBr_2 are low triangular, about three times as broad as the median length, the lateral borders about as long as those of the IBr_1, well separated laterally. There are 6 IIBr series present, all 4(3+4). Each IIBr series bears two IIIBr 2 series, there being in all 12 of these. One IIIBr series bears a IVBr series of 2 on the inner side of the IIBr axillary and outer side of the following IIIBr axillary. The division series are well separated, well rounded dorsally, the sides smooth without lateral projections or carination. The ossicles immediately following each axillary are united interiorly.

The 29 arms are 130 mm. long. The first eight brachials are approximately oblong, about three times as broad as long, those following becoming obliquely wedge-shaped, almost triangular, about three times as broad as long, then less obliquely wedge-shaped, and almost short oblong or discoidal in the outer half of the arm, though never regularly short discoidal as in *Himerometra.* The brachials are slightly overlapping.

On an arm arising from a IBr axillary P_1 is 9 mm. long, moderately stout basally but tapering rapidly and becoming slender and almost flagellate in its distal half. It is composed of 28 segments of which the first is large and broad, about twice as broad as long, the second is smaller but similarly proportioned, the third is slightly longer, and those following are similar to the third, but become short in the terminal 10 or 12. The larger proximal segments are moderately carinate, the carination being somewhat roughened and finely tubercular. P_2 is 13 mm. long, stout basally and tapering to a slender tip, with 31 segments of which those in the proximal half are not so long as broad and rather strongly carinate, the following are about as long as broad with diminishing carination, and the terminal are short. P_3 is 21 mm. long, stouter than P_2, tapering evenly to a slender tip, with 38 segments most of which are about as long as broad, rather shorter basally and rather longer distally. The segments in the proximal half have somewhat tubercular carinate processes which, however, are never very large, and there is a prominent ridge running along the entire pinnule distal to the median outer line. P_4 is 25 mm. long, about as stout basally as P_3 and similar to it, with 38 segments. P_5 is 14 mm. long, about as stout basally as P_1 but tapering more evenly and not so slender distally, with 25 segments, most of which are not quite so long as broad. P_D is like P_1 as described, though somewhat smaller. On arms springing from a IIIBr axillary P_1 is like P_1 as described, P_2 is 17 mm. long, like P_2 as described, with 35 segments, P_3 is 28 mm. long, with 38 segments, resembling P_4 as described, and P_4 is 14 mm. long resembling P_5 as described. The carination of the proximal pinnule segments dies away after about P_{16}. The distal pinnules are small and very delicate, 7 mm. long.

The color in alcohol is uniform dark brown.

Notes.—In the specimen collected by the *Investigator* in the Andaman Islands the cirri are X, 43+, 50 mm. long. There are 22 arms 120 mm. long. All the IIBr series are present. The two IIIBr series are 2, developed internally. The color is whitish, the articulations purple, the arms crossed by regular broad deep purple bands; the cirri are white, each segment with a saddle of purple ventrally, becoming rusty brown at the tip.

The specimen from Yé, Burma, is an especially fine example of the species. The cirri are XII, 42+, 43+, and 44+. There are 36 arms 90 mm. long. The IIBr series are all 4(3+4), and the IIIBr series are all 2; the 10 internal IIIBr series are all present, and in addition there are six external IIIBr series. The synarthrial tubercles are prominent.

In the specimen from the Mergui Archipelago the cirri are XIII, 43–44, 40 mm. long. There are 31 arms 120 mm. long. The IIBr series are all present, and all are 4(3+4). The 10 internal IIIBr series are all present, and there is an additional external one. Two of the IIIBr series are 4(3+4), the other nine being 2.

In color the two last are yellowish white, the pinnules with occasional small irregular blotches of light purple; the cirri are white, becoming rusty brown at the tip, each segment with a saddle of dull purplish.

The specimen from Singapore collected by M. Maindron is small, with 13 arms. The two IIBr series are 4(3+4). The single IIIBr series, which is internally developed, is 2. The cirri have 28–34 segments. This specimen resembles the following.

The specimen collected by Svend Gad at Singapore has the centrodorsal moderate in size, discoidal, with the bare polar area flat. The cirri are XI, 36–40, 35 mm. long, very stout basally but tapering, with especial rapidity in the distal third, to a very sharp and slender tip. The first segment is very short and those following gradually increase in length to the seventh, which is about as long as broad, after the middle of the cirrus becoming very gradually longer than broad, and about half again as long as broad in the terminal portion. The terminal claw is long and slender, about as long as the penultimate segment, and is slightly curved. There are 19 arms. Four IIBr series are present, one on each of four postradial series; all of them are 4(3+4). Two of the IIBr series bear two IIIBr series each, and the two other IIBr series bear a single IIIBr series each, developed internally. All the IIIBr series are 2. P_1 is about 5 mm. long and is composed of 18 segments all of which are about as long as broad, and the second-fifth are rather strongly carinate. P_2 is 11 mm. long, much stouter than P_1 but tapering evenly to a slender and delicate tip, and is composed of 28 segments, which at first are about twice as broad as long, becoming about as long as broad on about the sixth, then slowly increasing in length and being about twice as long as broad distally, but shorter again terminally. P_3 is 20 mm. long, stouter than P_2 but, like it, tapering evenly to a slender and delicate tip. The fourth-sixth segments are about as long as broad, and those following gradually increase in length, being about twice as long as broad distally. The second-fifth or -sixth segments are, as in P_2, rather strongly carinate. P_4 is shorter than P_2 and is less stout and stiff; like the pinnules following it is composed of mostly squarish segments.

One of the specimens from off Cape Jabung has 28 arms, and another has 22 arms.

Nine of the specimens from near Deli have 22 (one), 23 (two), 24 (three), 26 (one), 28 (one), and 29 (one) arms. In the specimen with 28 arms the arms are about 140 mm. long.

In one of the specimens from Malacca Strait near the mouth of the Deli River there are 35 arms; all the IIIBr series are 2.

Prof. Ludwig Döderlein recorded two specimens from Amboina without comment. He gave a reference to Hartlaub, and it is quite probable that he determined the specimens from Hartlaub's description and figures. If this is true they represent *Heterometra amboinae* and not this species.

The specimen from Hongkong described as *Antedon ludovici* by Carpenter presented, according to him, the following characters: The centrodorsal is a thick disk with a flattened dorsal surface and a single or partially double row of cirri. The cirri are XXV, 40–50. The cirrus segments are tolerably equal, all of them, except for those at the extreme end, being broader than long. Even in these terminal segments the length is but little greater than the width; they bear a slight tubercle in the middle of the dorsal surface which is most marked on the penultimate segment. The radials are partially visible. The IBr_1 are short, widely oblong, almost completely united laterally, and slightly raised in the middle of their junction with the axillaries. The IBr_2 (axillaries) are half again as long as the IBr_1, widely pentagonal, with open distal angles, and also slightly raised in the middle of the proximal edge. The 30 arms are 100 mm. long and are composed of 150+ brachials. The postradial series may divide three times. The IIBr series are 4(3+4), and the IIIBr series are 2. The first ossicles following each axillary are rhomboidal and are closely united laterally, with the distal edge very slightly incised to receive the convex hinder edge of the following ossicle. The first syzygial pair, composed of brachials 3+4, is short and oblong. The next four or five brachials are also short with somewhat oblique terminal faces and slight backward projections alternately on the inner and outer sides. The fourth and sixth brachials are thus longer on their inner sides, and the fifth and seventh on their outer ones. The following brachials are short, bluntly wedge-shaped, and overlapping, nearly twice as broad as long, becoming more oblong about the middle of the arm. The first syzygy is between brachials 3+4, and the next is from between brachials 9+10 to between brachials 17+18, usually between brachials 13+14; there is then an interval of 8–15 (usually 10 or 11) muscular articulations between the syzygies.

P_D is quite small, little more than half as long as, and far more slender than, those on the second and third brachials, which are about equal. The next pair are still larger, and the third pair (on the sixth and seventh brachials) still more so, consisting of about 35 stout segments and reaching nearly 35 mm. in length. That on the seventh brachial is rather the smaller, and the next pair is considerably smaller, only about equal to the first pair. The diminution continues to about the seventh pair, which are not especially small, being scarcely less than 10 mm. long. The remaining pinnules are of about the same length, but gradually become slenderer. The basal segments of the lower pinnules from P_D onward have rather sharp dorsal keels. These may be less marked on the stout segments of the pinnules of the second and third pairs, but reappear on the second and four following segments in the fourth pair, and then gradually decrease in distinctness, disappearing altogether by about the twenty-fifth segment. The disk is naked and considerably incised and is 15 mm. in diameter. Sacculi are closely set along the pinnule ambulacra. The color in alcohol is light brown.

The other specimen from Hongkong was described by Carpenter as *Antedon bipartipinna* in the following terms. The centrodorsal is a thick slightly convex disk bearing a single row of cirri. The cirri are XIV, with nearly 60 segments and may reach almost 60 mm. in length. They are long and stout. The basal segments are very broad, nearly 2 mm. in width, the fifteenth and following are about as long as broad, and the terminal are slightly longer than broad, quite smooth dorsally. The terminal claw is very imperfectly formed and there is no trace of an opposing spine. The radials are partially visible at the angles of the calyx. The IBr_1 are shorter in the middle line than laterally, where they are closely united to their fellows. The IBr_1 and the short, almost triangular, axillaries rise to a slight tubercular elevation in the middle line of their junction. The IIBr series are 4(3+4). The IIIBr series are usually 4(3+4) but sometimes 2. The first ossicles after each axillary are rhomboidal and closely united laterally, and the second are more wedge-shaped. The middle of the articulation between the first two ossicles is tubercular, as in the case of the articulation between the elements of the IBr series. The division series are in close lateral contact. The 35 arms are nearly 125 mm. long and consist of 200+ brachials. The first syzygial pair (composed of brachials 3+4) and the next four or five brachials are oblong, and the following brachials are short, sharply wedge-shaped, and very slightly overlapping, twice as broad as long. About the middle of the arm the brachials become more equal sided, and they are nearly oblong in the terminal portion. Syzygies occur between brachials 3+4, again from between brachials 12+13 to between brachials 16+17, and distally at intervals of from 7 to 13 (usually 9 or 10) muscular articulations.

P_D is quite short. P_P, P_1, and P_2 are rather longer. They all have somewhat the appearance of being in two parts, as if they had been broken and had regenerated. The lower half consists of wide and thick segments with dorsal keels, while the outer half is composed of quite small segments and grows, as it were, out of the middle of the wide lower portion. This is least marked on P_2, which is nearly twice as long as P_1 and is stouter and more uniformly tapering. P_3 is still longer, reaching 25 mm. in length and consisting of about 50 broad segments, of which the lower are keeled. P_4 is nearly as long but is less stout. On the inner side of the arm the seventh brachial bears a large pinnule (P_c) like the preceding one (P_3). That on the fifth brachial (P_b) is much smaller, and that on the ninth (P_d) is variable, sometimes small and sometimes nearly as large as its fellow of the fourth pair. In some arms the fourth or eighth segments may bear the largest pinnule (that is, P_2 or P_4 may be the largest). Beyond the fourth pair (P_4 and P_d) the length decreases, rapidly at first but afterward more gradually until about the twentieth (twenty-second counting syzygial pairs as two brachials) brachial beyond which the pinnules are tolerably uniform in size, decreasing again toward the arm tips. The carination of the basal segments of the lower pinnules dies away gradually and is lost after the tenth pair. The disk is naked and much incised, 15 mm. in diameter. Sacculi are closely set along the pinnule ambulacra. The color is deep purple, almost black.

Hartlaub wrote that the type specimen of *Antedon bipartipinna*, which he examined at Hamburg, at first gives quite the same impression as one of the specimens from Amboina which he identified as *Antedon ludovici* (=*Heterometra amboinae;* see page 297). The most striking features are afforded by the cirri, which are long and stand in a single row and have no opposing spine or terminal claw. But Hartlaub said that one cannot attribute great weight to these features, since certain aspects of the specimen point to an abnormal development. First of all, there is the irregular position of the first brachial syzygy. On many arms it lies between brachials 3+4, on others between brachials 2+3, and on still others there is a syzygy between brachials 3+4 and another between brachials 5+6; in individual cases the first brachial syzygy is between brachials 12+13 or 13+14. Concerning the peculiarities of the lower pinnules Hartlaub said that it is a fact that they have been broken off and regenerated. Their structure, however, corresponds completely to that characteristic of the lower pinnules of *A. ludovici*. He said further that both species further agree in the possession of both IIIBr 2 and IIIBr 4(3+4) series. Carpenter's statement that the IIIBr series are usually 4(3+4) but sometimes 2 is not correct. The specimen has many more IIIBr 2 than IIIBr 4(3+4) series, and indeed the inner IIIBr series are for the most part 2.

I examined both these specimens from Hongkong at the Hamburg Museum in 1910. They undoubtedly represent the same species as the one without locality that Carpenter described as *Antedon acuticirra*. The second specimen from Hongkong, described as *Antedon bipartipinna* by Carpenter, has slightly smoother arms than the type of *A. acuticirra*.

The specimen without locality was described as *Antedon acuticirra* by Carpenter in the following terms. The centrodorsal is a thick disk with a flat dorsal surface and the cirri arranged in a single marginal row. The cirri are XV, 55, and may reach 50 mm. in length. They are long and tapering and consist of smooth segments. The basal segments are broad, and the tenth is about as long as broad, while those following diminish in width and thickness, though the length changes but little. The later ones are longer than broad but are not laterally compressed. The cirri taper gradually to a sharp point. There is no trace of an opposing spine. The terminal claw is small and is but slightly curved. Some of the radials are partially visible, and some of the short IBr$_1$ are partly concealed. The IBr$_1$ are closely united laterally. The IBr$_2$ (axillaries) are nearly twice as long as the IBr$_1$, almost triangular, with open distal angles. The IIBr series are 4(3+4), and the IIIBr series are usually 2, but sometimes 4(3+4). The first ossicles following each axillary are closely united interiorly, and there are slight synarthrial tubercles. The 26 arms are about 125 mm. long and are composed of 200+ brachials. The first brachials are rhomboidal, short and broad. The second brachials are more wedge-shaped. The first syzygial pair (composed of brachials 3+4) and the next four or five brachials are short and oblong, the following brachials are bluntly wedge-shaped, twice as broad as their longer side and slightly overlapping, and the middle and later brachials are more oblong and overlap rather less. Syzygies occur between brachials 3+4, again from between brachials 10+11 to between brachials 17+18, and distally at intervals of 6 to 33 (usually 11 to 16) muscular articulations.

P_D is comparatively small, with keeled and expanded basal segments. P_1 is considerably larger on the outer arms but remains small on the inner ones. P_2 and P_3 increase in size, the latter reaching 25 mm. in length and consisting of nearly 40 segments. P_a is small like P_D, and P_b and P_c are much larger, P_c approaching the size of P_3. P_4 is somewhat smaller again, though it is still long, and the next pair are a good deal shorter than their immediate predecessors, though somewhat larger and stouter than P_1. Where IIBr series are not present but the arms arise from a IBr axillary, the fourth pair of pinnules are large like their immediate predecessors. The size of the pinnules decreases to about the seventeenth brachial and then increases very slowly again, the outer pinnules reaching only about one-third the length of the largest lower pinnules, which have broad and strongly keeled basal segments. On the smaller pinnules after the fifth pair this carination is less marked, but it is traceable for some little way out on to the arms. The disk is naked and considerably incised, 15 mm. in diameter. Sacculi are very close along the pinnule ambulacra. The color is nearly white, with traces of a deep violet remaining.

I examined this specimen at the Hamburg Museum in 1910. The synarthrial tubercles are rather prominent, and the distal edges of the brachials are rather strongly overlapping. It is just like others from the eastern side of the Bay of Bengal.

In the remarks following his description of *Antedon acuticirra* Carpenter mentioned a specimen from Sydney, New South Wales, which he had seen in the Copenhagen Museum bearing the manuscript name *Antedon australis* Lütken. This is the specimen from which the description given above (page 216) was drawn up. Carpenter said that it has some resemblance to *Antedon acuticirra.* It has the same arrangement of the division series, a few long and many-segmented cirri, and a large third pair of pinnules. But it has relatively shorter axillaries and a shorter intersyzygial interval, usually 7–9 instead of 11–16 muscular articulations. He said that without a more detailed examination of the Copenhagen specimen than he had up to that time been able to make it was difficult to be certain as to its identity with the one which he described as *Antedon acuticirra.*

Localities.—Investigator; Andaman Islands [A. H. Clark, 1912] (1, U. S. N. M., 36177, 36198).

Investigator; Yé, Burma (on the eastern shore of the Gulf of Martaban, at about lat. 15°20′ N.) [A. H. Clark, 1912] (1, I. M.).

Investigator; Gregory Island, Mergui archipelago [A. H. Clark, 1912] (1, U. S. N. M., 35199).

East side of Trotter Island, Mergui archipelago; November 30, 1913 [A. H. Clark, 1932] (1, I. M.).

Singapore; M. Maidron, 1884 [A. H. Clark, 1911] (1, P. M.).

Singapore; Svend Gad [A. H. Clark, 1909, 1912] (1, C. M.).

Off Cape Jabung, northern coast of southern Sumatra (lat. 1°03′ S., long. 104°35′ E.); July 3, 1908 [A. H. Clark, 1933] (3, Buitenzorg Mus.).

Near Deli, northern Sumatra (lat. 3°40′ N., long. 99°10′ E.); 16–18 meters; June 25, 1908 [A. H. Clark, 1933] (48, U. S. N. M., E. 3247; Buitenzorg Mus.).

Malacca Strait, near the mouth of the Deli river, Northeastern Sumatra (lat. 3°53′ N., long. 98°46′ E.); 10 meters; June 22, 1908 [A. H. Clark, 1933] (4, Buitenzorg Mus.).

?Amboina; Prof. Richard Semon [Döderlein, 1898; A. H. Clark, 1912].

Albatross station 5157; Tawi Tawi group, Sulu (Jolo) archipelago; Tinakta Island (N.) bearing S. 80° W., 3.3 miles distant (lat. 5°12′30″ N., long. 119°55′50″ E.); 33 meters; fine sand; February 21, 1928 (1, U. S. N. M., 35186).

Hongkong [P. H. Carpenter, 1882, 1883, 1888; Hartlaub, 1891; A. H. Clark, 1909, 1912] (1, H. M.).

Hongkong [P. H. Carpenter, 1882, 1883, 1888; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912] (1, H. M.).

No locality [P. H. Carpenter, 1882, 1883, 1888; Hartlaub, 1891; A. H. Clark, 1909, 1912] (1, H. M.).

Erroneous locality.—Sydney, New South Wales [P. H. Carpenter, 1882; A. H. Clark, 1909, 1911, 1912] (1, C. M.).

Geographical range.—From the Gulf of Martaban and the Andaman Islands to Amboina and northward to the Philippine Islands and Hongkong.

Bathymetrical range.—Littoral and sublittoral; from the shore line down to 33 meters.

History.—In a paper on the comatulids of the Hamburg Museum published in 1882, Dr. P. H. Carpenter described a specimen without locality under the name of

Antedon acuticirra, and in discussing this mentioned another specimen from Sydney in the Copenhagen Museum bearing the manuscript name *Antedon australis* given it by Lütken which had some resemblance to it. He also described two other species, *Antedon ludovici* and *A. bipartipinna,* both of which were based upon single specimens from Hongkong. In the key to the species discussed in the paper he included *Antedon acuticirra* and *A. ludovici* under the headings "Rays divide three times. First division of three joints, the axillary with a syzygy; second of two joints, the axillary without a syzygy [that is, IIBr series 4 (3+4) and IIIBr series 2]" and also "Fifty or more cirrus-joints. Lower pinnules similar on all the arms." The characters by which he distinguished *acuticirra* from *ludovici* were that in *acuticirra* the terminal cirrus segments are smooth, while in *ludovici* the distal cirrus segments have dorsal tubercles. As given in the key the chief characters of *A. bipartipinna* are "Rays divide three times, each division of three joints, the axillary with a syzygy [that is, the IIBr and IIIBr series are both 4 (3+4)]," while the cirri are long and stout with an imperfect terminal claw and smooth terminal segments.

In the following year Carpenter gave specific formulas for *Antedon acuticirra, A. ludovici,* and *A. bipartipinna.*

In the *Challenger* report on the comatulids published in 1888, Carpenter gave emended specific formulas for *Antedon acuticirra, A. ludovici,* and *A. bipartipinna,* and mentioned (in discussing *Antedon* [*Thalassometra*] *bispinosa*) that in *A. acuticirra* the "radial axillaries" (the IBr_2) come into contact above the depressed lateral portions of the second radials (the IBr_1). As none of these forms had been secured by the *Challenger* Carpenter did not discuss them in detail, merely including them in the key to the species of the "*Savignyi* group." In this key he gave *acuticirra* as having the cirrus segments smooth and longer than broad, with no opposing spine, while in *ludovici* the cirrus segments are broader than long, the outer have faint tubercles, and the penultimate has an opposing spine. In the key *Antedon bipartipinna* was paired with *A. philiberti,* these two forms being, according to Carpenter, distinguished from all the other species in the "*Savignyi* group" by the possession of IIIBr 4 (3+4) series. Of *A. bipartipinna* he said that there are nearly 60 cirrus segments of which the outer are longer than broad and quite smooth, while the terminal segments of the lower pinnules are much smaller than the basal ones. He gave *A.* [*Heterometra*] *philiberti* as having 45 cirrus segments of which the later are short and spiny.

In studying the collection of comatulids made by Prof. J. Brock at Amboina, Dr. Clemens Hartlaub found 12 specimens that he at first considered as representing a new species. He accordingly prepared a detailed description of them, but later he decided that they belonged to the form which had been described by P. H. Carpenter as *Antedon ludovici.* In 1891 he published the description he had drawn up under that name, in which he included *Antedon acuticirra* as a synonym and *A. bipartipinna* as a probable synonym. He said that he had sent a specimen from Brock's Amboina collection to Carpenter, who had pointed out that it was apparently identical with his *Antedon ludovici* from Hongkong and that he convinced himself of the correctness of this conclusion by an examination of the type specimen of *ludovici* at Hamburg. He gave a detailed comparison between his Amboina specimens (which really represent *Heterometra amboinae;* see page 297) and the type specimen of *Antedon ludovici.* He regarded the Chinese form (*ludovici*) to which he assigned also the type specimens of

Antedon bipartipinna and *A. acuticirra* as very variable, but believed it to differ constantly from the Amboina form in the greater number of arms. He said that the principal reason that led him to consider the Chinese and Amboina forms as identical was the agreement in the form of the cirri, arms, brachials, and pinnules. He regarded as also characteristic the synarthrial tubercules, the shortness of the first syzygial pair, the uneven dorsal surface of the first 7 or 8 brachials, and the carination of the pinnules in the proximal portion of the arms. He wrote that if one places weight on these apparently constant characters, and if one also takes into consideration the obvious inclination of *A. ludovici* toward variation, it may well be asked whether *A. bipartipinna*, coming also from Hongkong, is not really the same species.

In 1895 Prof. René Koehler recorded this species from Amboina, and in 1898 Prof. Ludwig Döderlein again recorded specimens from Amboina. Koehler's record was based on specimens of *Heterometra amboinae* (see page 300), and it is probable that Döderlein's record was based on the same species.

In 1907 I referred *ludovici*, considered as including *acuticirra*, *australis*, and *bipartipinna*, to the new genus *Himerometra*. In 1909 on the establishment of the new genus *Craspedometra* I listed as referable to this genus *Craspedometra acuticirra*, *C. australis*, *C. bipartipinna*, and *C. ludovici*.

Thanks to the kindness of Dr. Th. Mortensen I had been able to examine the specimen supposedly from Sydney in the Copenhagen Musem that bore Lütken's manuscript name *Antedon australis*. Later in 1909 I published a description of this specimen, referring it to *Craspedometra acuticirra*. At the same time I recorded and gave notes upon a specimen from Singapore. I remarked that this specimen is so different from the one from Sydney that I at first considered it as a representative of a different species, which was the reason for describing it so minutely. Subsequently I had had the opportunity of studying the series of specimens belonging to the Indian Museum at Calcutta, and my examination of these specimens proved to my satisfaction that the example from Sydney and the one from Singapore, different in general appearance as they are, really belong to the same specific type.

In 1911 I recorded another specimen from Singapore that I had seen in the Paris Museum in 1910, and in 1912 I gave notes upon the type specimens of *Antedon acuticirra*, *A. ludovici*, and *A. bipartipinna*, which I had examined at the Hamburg Museum. All three forms, together with *A. australis*, I referred to the same species, which I called *Craspedometra acuticirra*.

In my monograph on the crinoids of the Indian Ocean, which was published in 1912, I included *Antedon ludovici*, *A. australis*, and *A. bipartipinna* in the synonymy of *Craspedometra acuticirra*, and recorded three specimens, one from the Andaman Islands, one from the Mergui Archipelago, and one from the Burmese coast, giving notes on all three.

In 1932 I recorded from the collection of the Indian Museum a broken specimen from Trotter Island, and in 1933 I recorded and gave notes upon 55 specimens from three localities off the coast of Sumatra in the collection of the Buitenzorg Museum in Java.

Dr. Th. Mortensen in 1934 listed this species as one of the crinoids known from Hongkong.

Genus HETEROMETRA A. H. Clark

Comatula (part) Audouin, *in* Savigny, Description de l'Égypte, 1817 (1826), p. 205, and following authors.

Alecto (part) J. Müller, Monatsber. preuss. Akad. Wiss., 1841, p. 185.

Comatula (*Alecto*) (part) J. Müller, Monatsber. preuss. Akad. Wiss., 1846, p. 178.

Antedon (part) P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29, and following authors.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Amphimetra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7.

Craspedometra (part) A. H. Clark, Proc. U. S. Nat. Mus., vol. 37, 1909, p. 31.

Heterometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 11 (diagnosis; genotype *Antedon quinduplicava* P. H. Carpenter, 1888); Amer. Nat., vol. 43, 1909, p. 254 (represented in the Red Sea); Zool. Anz., vol. 34, 1909, p. 367 (arm division similar to that of *Antedon fluctuans* [*Zygometra comata*]); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 175 (referred to the Himerometrinae); A. H. Clark, Mem. Australian Mus., vol. 4, 1911, pp. 731, 732 (in keys), p. 734 (key to the Australian species), p. 767 (original reference; characters; range); Crinoids of the Indian Ocean, 1912, p. 9 (possesses additional species in Australia), p. 10 (absent from Japan; reason), p. 11 (represented in the Ceylon region; this the western limit of the large and highly multibrachiate species), p. 12 (represented in Red Sea region and in southeast African region), p. 21 (range in detail), p. 56 (in key), p. 120 (original reference; type); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 311 (discussion of the small species and comparison with the small species of *Zygometra*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 72 (in key; range), p. 75 (key to the included species).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 45, 46, 48.—A. H. Clark, Temminckia, vol. 1, 1936, p. 305.—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 17.

Diagnosis.—A genus of Himerometridae in which the cirri are of moderate length with the distal segments always bearing dorsal tubercles or spines and the terminal claw always strongly curved; the distal cirrus segments are usually shorter than the proximal, or both distal and proximal cirrus segments are short; P_1 is shorter and slenderer than P_2, and P_2 is usually shorter and more slender than P_3; the enlarged proximal pinnules are much elongated, slender or rather stout, smooth, basally carinate, or with the outer segments armed at the distal end with spines or flangelike projections; there are more than 10 arms.

In a few species 10-armed individuals occur, but these are always distinguishable from the species of *Amphimetra* by the characteristic proximal pinnules which are strongly keeled basally or have their outer segments provided distally with spines or flangelike projections.

Geographical range.—From southern Japan southward to Port Curtis, Queensland, and Baudin Island, northwestern Australia, and westward to Madagascar and the eastern coast of Africa from the Red Sea south to Zanzibar and Bagamoyo.

Bathymetrical range.—From the low-tide mark down to 111 meters. The species of *Heterometra* are especially characteristic of the zone from the low-tide mark down to about 50 meters. Of the 25 species only 7 are known from a greater depth than 50 meters, and all but 4 have been taken in shore collecting.

Remarks.—The genus *Heterometra* includes a rather heterogeneous assemblage of 25 species. In the genus as a whole all the characters of the cirri, pinnules, and arms are exceedingly variable and more or less overlap those of the other genera of the family Himerometridae. The species of the genus *Heterometra* are therefore recognizable not so much by a special and distinctive generic combination of characters as by the fact that they do not fall in the genera *Craspedometra, Himerometra, Amphimetra*, or *Homalometra.*

The genus *Heterometra* is divisible into five fairly well marked groups, which might possibly be considered as of subgeneric value. But with our present meager knowledge of most of the species it is quite inadvisable to subdivide it.

In the first group the enlarged lower pinnules are comparatively slender and are entirely smooth, with no carination of the basal segments and no modification of the distal ends of the outer segments. The two species in this group, *H. savignii* and *H. nematodon,* appear not to be very closely related to each other.

Another group in which the cirri are smooth, the distal segments being without dorsal processes although they may be more or less strongly carinate, and the enlarged lower pinnules are usually smooth though in large individuals the basal segments may be slightly carinate, is represented by *H. quinduplicava* only. Though in the character of the enlarged lower pinnules *H. quinduplicava* is intermediate between the species with these pinnules smooth and the species with these pinnules carinate basally, it is quite unique in the character of its cirri.

In a third group the enlarged lower pinnules have the outer segments with their distal ends armed with spines or with rounded triangular extensions of the distal portions of the prismatic ridges. In *H. variipinna* the enlarged lower pinnules are composed of cylindrical segments with spinous distal ends, while in *H. crenulata* the lower pinnules are very strongly prismatic with the distal ends of the prismatic ridges on each segment produced into conspicuous rounded triangular lateral extensions so that the profiles of these pinnules are very strongly serrate, the teeth being broadly rounded. *Heterometra crenulata* is exceedingly variable in every feature. Individuals are not infrequent in which there are only 10 arms, though in others there may be as many as 30 arms. Individuals vary from extraordinarily robust with stiff and spinelike enlarged lower pinnules to very slender with slender lower pinnules which become almost flagellate distally. The processes on the segments of these pinnules may be broad and involve basally a large part of the segment, or they may be reduced to scarcely more than an overlapping spine. The cirri may be prominently spiny or practically smooth, stout, or slender and tapering. Some forms of *H. crenulata* approach *H. producta*—which may possibly turn out to be merely an extreme variation of it—while *H. producta* and *H. propinqua* probably will be found to intergrade. Although *H. crenulata* and *H. variipinna* seem to be so very different, the enlarged lower pinnules in the latter may be more or less prismatic, at least basally, suggesting that the two species may be rather closely allied.

In all the other species of *Heterometra* the enlarged lower pinnules are entirely smooth, but their earlier segments bear more or less strongly developed and usually conspicuous carinate processes on the side toward the arm tip. They are divisible into two quite distinct groups.

The first of these, or the fourth group of *Heterometra* as a whole, includes 11 species—*astyanax, affinis, reynaudi, amboinae, ater, joubini, pulchra, gravieri, compta, singularis,* and *madagascarensis.* In these species the brachials, though actually short, are relatively long, and are always more or less wedge-shaped with oblique ends, the earlier brachials, beyond the first few, being markedly wedge-shaped and in some cases almost triangular. This group is divisible into three subgroups—one in which the cirri are long and tapering with the outer segments longer than broad and with only slight dorsal tubercles, including *astyanax* only; one in which the outer cirrus segments are broader than long but some of the earlier are as long as, or longer than, broad, including *affinis*, *pulchra*, *gravieri*, *singularis*, *compta*, and *madagascarensis;* and one in which all the cirrus segments are markedly broader than long, including, *reynaudi*, *amboinae*, *ater*, and *joubini*. Some species are more or less on the border line between the last two subgroups. Through *H. astyanax* the first section of this group approaches very closely the genus *Craspedometra*, which possibly should not be separated from it, and in another direction it also approaches the slender and delicate *Homalometra*. Through *H. compta*, in which P_1 and P_2 are similar and of approximately the same length, the second section approaches the genus *Himerometra* as represented by *H. persica* and *H. bartschi*, though the brachial structure of the species of *Himerometra* is most nearly like that of the next group.

In the fifth and last group of the species of *Heterometra*, including *philiberti*, *sarae*, *parilis*, *africana*, *schlegelii*, *bengalensis*, and *flora*, the brachials are exceedingly short with parallel ends which become only slightly oblique on the earlier brachials. Within this group there are two subgroups, one, including *philiberti* only, in which IIIBr series occur and are wholly or mostly 4(3+4) instead of 2 as would be expected, and another, including *sarae*, *parilis*, *africana*, *schlegelii*, *bengalensis*, and *flora*, in which, so far as is known, IIIBr series never occur. The species of this group are evidently closely allied to the species of *Amphimetra*, and this relationship is emphasized by the occasional occurrence in some of them of fully grown individuals with only 10 arms. They approach the species of *Amphimetra* through *H. sarae* in which the earlier segments of the proximal pinnules have the carination reduced to a mere sharpening of the side toward the arm tip. Their brachial structure, and especially the occurrence of IIIBr 4(3+4) series in *philiberti*, indicates that they also approach the species of *Himerometra*, through *H. persica* and *H. bartschi*, more closely than do the species of any of the other groups.

Both of the species in the first group have a very limited range, *H. savignii* occurring only from the Red Sea to Muscat, and *H. nematodon* being found only in Queensland and the Aru Islands. The single species of the second group ranges from the Andaman Islands to the Philippines. The species of the third group occur from the Maldive Archipelago to the Philippines and southward to northern Australia. The species of the fourth group range from east Africa and the Red Sea to the Philippines and southward to the Torres Strait region. The species of the fifth group are found from east Africa to southern Japan, but are not represented in Australia.

The species of *Heterometra* are all inhabitants of very shallow water and are most abundant in a narrow band of a few meters' width just below the low tide mark. One species has been recorded from a depth of 111 meters, and others from a depth of 88 meters, but most of the records are for much shallower water. Indeed, of the 25 species only 4 (*astyanax*, *pulchra*, *compta*, and *propinqua*) have not been taken in ordinary shore collecting.

All the species are of medium or rather large size, but the largest of them are not so large as the larger species of *Himerometra*, or as the species of *Craspedometra*.

The species of *Heterometra* are among the most difficult of all comatulids to identify. Most of those of which any considerable number of individuals are known are exceedingly variable, generally or locally, in all their structural characters and also in their size.

History.—It is possible that the *Alecto horrida* described by Dr. W. E. Leach in 1815, which is the type species of the genus *Alecto*, represents the species described by Prof. Johannes Müller in 1846 as *Comatula* (*Alecto*) *reynaudi*. But Leach's description is very vague, his figure is not with certainty identifiable, and his type specimen can not be found, so that the identity of *horrida* with *reynaudi* rests on quite inconclusive circumstantial evidence.

The first indubitable species of this genus to be recorded was assigned by Savigny to the genus *Comatula;* it was figured in his account of the zoology of Egypt published in 1826 under the editorship of Audouin. In 1841 Prof. Johannes Müller referred the same species to *Alecto*, and in 1846 he described a second species under the generic designation *Comatula* (*Alecto*).

In 1879 Dr. P. H. Carpenter assigned *savignii*, *philiberti*, and *reynaudi* to the genus *Antedon* as understood by him. In 1882 he referred to the species of this type as belonging to the *Savignyii* group. In 1888 he defined the *Savignyi* group and included in it *reynaudi*, *savignyi*, and *philiberti*, the recently described *variipinna*, *acuticirra*, *ludovici*, and *bipartipinna* (the last three falling in the genus *Craspedometra* as now understood), and the new species *anceps*, *quinduplicava*, and *angustiradia* (the last a species of *Adelometra*). As one of the three specimens had only 10 arms, Carpenter also included *Antedon anceps* in his *Milberti* group. *Antedon clemens* he included in his *Palmata* group which consisted of species with the IIBr series 2.

Hartlaub in 1891 followed Carpenter in placing *clemens* in the *Palmata* group, and included in the *Savignyi* group *angustiradia*, *reynaudi*, *savignyi*, *anceps*, *variipinna*, *quinduplicava*, *ludovici*, *bipartipinna*, and *philiberti*, and his new species *bengalensis*, *martensi*, *kraepelini*, *brockii*, *affinis*, *nematodon*, and *crassipinna*.

The *Savignyi* group of Carpenter and Hartlaub was therefore the equivalent of the very closely allied genera *Heterometra*, *Himerometra*, and *Craspedometra* combined.

In my first revision of the old genus *Antedon*, which was published in 1907, the species of *Heterometra* were all referred to the new genus *Himerometra*.

In a revision of the family Himerometridae published in 1909, the genus *Himerometra* was redefined in such a way as to include only those species in which P_D is larger and longer than P_1, which in turn is larger and longer than P_2. The species with IIBr 4(3+4) series and therefore more than 10 arms, and P_D smaller than P_1, were distributed among three genera. The species in which the middle and distal brachials are exceedingly short and discoidal and the elements of the division series and lower brachials are swollen were assigned, together with a number of 10-armed species, to the new genus *Amphimetra*. These species were *anceps* (=*quinduplicava*), *producta*, *schlegelii*, and *variipinna* (in the sense used by Carpenter, that is, including both *variipinna* and *crenulata*). The species with the middle and distal brachials not especially short, more or less obliquely wedge-shaped, and the elements of the division series and earlier brachials not swollen, were assigned to the new genus *Heterometra*. These species were *affinis*, *bengalensis*, *brockii* (=*variipinna*), *quinduplicava*, *reynaudi*, and *savignii*. The species with the cirri tapering distally, the distal cirrus segments twice as long as broad, and no opposing spine, were assigned to the new genus *Craspedometra*. The only species at that time included in *Craspedometra* which is of present interest was *ludovici* which the author accepted on the basis of Hartlaub's description of specimens from Amboina (=*H. amboinae*) published in 1891. Müller's *philiberti* was assigned to the genus *Himerometra* with a query.

In the same year (1909) I described, under the name *Craspedometra aliena*, a supposed new species from the Philippines. The type specimen of this supposed new species is an example of *H. crenulata*, while other specimens in the type series represent *H. quinduplicava*. In another paper also published in 1909 I described *Amphimetra mortenseni*.

In 1911 a specimen was recorded from the Philippines under the name *Craspedometra anceps* (=*quinduplicava*), and *Antedon clemens* and *Craspedometra aliena* were placed in the synonymy of *anceps*.

In a paper on the crinoids of the coasts of Africa published in the same year, *Amphimetra africana*, *Craspedometra ater*, and *Craspedometra madagascarensis*, all referable to *Heterometra* as herein understood, were described, and in a paper on the crinoids of the Paris Museum, which appeared a few months later, the type specimen of Müller's *philiberti* was described under the name of *Amphimetra philiberti*, of which the recently described *Amphimetra mortenseni* was said to be a synonym.

In my memoir on the crinoids of the Indian Ocean published in 1912, the genus *Heterometra* is given as including *nematodon*, *reynaudi*, *savignii*, *compta*, *affinis*, *brockii* (=*variipinna*), *martensi* (=*Himerometra martensi*), *joubini*, *gravieri*, *aspera* (=*bengalensis*), *singularis*, *bengalensis*, *quinduplicava*, and, in an appendix, *pulchra*. In the genus *Amphimetra* are placed *philiberti* (including *mortenseni*), *variipinna* (including *crenulata*), *producta*, *schlegelii*, *africana*, and a number of 10-armed species. To *Craspedometra* are assigned *ater*, *madagascarensis*, *amboinae* (a new name for the species described and figured as *ludovici* by Hartlaub), and *anceps*.

In a paper on the crinoids of the Hamburg Museum published in 1912 *philiberti*, *schlegelii* (from which the 10-armed individuals are excluded and considered as representing *laevipinna*), *nematodon*, *crenulata*, and *variipinna* are assigned to *Amphimetra*.

In a paper on the crinoids of the Berlin Museum published in the same year *africana* is assigned to *Amphimetra*, *ater* and *madagascarensis* to *Craspedometra*, and *savignii* to *Heterometra*.

In a paper on the crinoids of the British Museum, which appeared in 1913, *Amphimetra* is given as including *crenulata*, *nematodon*, *anceps*, *producta*, *flora* (sp. nov.), and *africana*, as well as several 10-armed species; Hartlaub's *martensi* is correctly assigned to *Himerometra;* and *quinduplicava*, *reynaudii*, and *savignii* are given under *Heterometra*.

Dr. August Reichensperger in his memoir on Merton's crinoids from the Aru and Kei Islands published in 1913 recorded and discussed *Amphimetra variipinna*, *Craspedometra amboinae*, and *Craspedometra anceps*, and Dr. Torsten Gislén in his account of Mjöberg's crinoids from northwestern Australia published in 1919 (but written before the appearance of the *Siboga* report in 1918) discussed *Amphimetra variipinna*.

For some time it had been increasingly evident that the genera *Heterometra*, *Amphimetra*, and *Craspedometra* were quite artificial and could not be maintained on the basis of the original diagnoses. So a thorough revision of the family Himerometridae was undertaken, and the results of this study were incorporated in the report upon the unstalked crinoids of the *Siboga* expedition, published in 1918. In this report *Heterometra* was given as including *quinduplicava* (including *clemens* and *anceps*), *savignii*, *nematodon*, *variipinna* (including *brockii*), *producta*, *propinqua*, *crenulata* (including *Comatula dubia* von Graff, 1877, *Antedon decipiens* and *A. irregularis* Bell, 1884, *Antedon bidentata* von Graff, 1884, *Antedon dubia* P. H. Carpenter, 1888, and *Craspedometra aliena* A. H. Clark, 1909, with the exception of the 10-armed specimens mentioned in the description of the last named), *philiberti* (including *mortenseni*), *flora*, *africana*, *schlegelii*, *singularis*, *pulchra*, *amboinae*, *joubini*, *gravieri*, *ater*, *madagascarensis*, *reynaudii*, *compta*, *aspera* (=*bengalensis*), *bengalensis*, and *affinis*. This interpretation of the genus *Heterometra* has been accepted herein, but the key to the species given in the *Siboga* report proving rather unsatisfactory, entirely new keys have been prepared.

KEY TO THE SPECIES IN THE GENUS HETEROMETRA

a^1. Outer cirrus segments smooth dorsally, or with a slight median keel, never with dorsal spines or tubercles; 25–36 (usually about 30) cirrus segments; 16–26 arms 60–145 mm. long; division series rather broad with slightly produced borders, though not in contact beyond the IBr axillary (from Philippines to Andaman Islands; 0–80 meters)........**quinduplicava** (p. 245)

a^2. Outer cirrus segments bearing spines or tubercles dorsally.

  b^1. Basal segments of the enlarged proximal pinnules without carinate processes on the side toward the arm tip.

    c^1. Enlarged proximal pinnules smooth and slender, their component segments without lateral processes or spinous distal ends.

      d^1. Usually 20 arms, up to 125 mm. in length; enlarged lower pinnules very long and slender, composed of about 20 segments; cirri composed of 23–33 (usually 25–30) segments of which the outer bear long dorsal spines (Red Sea and eastward to Muscat; 0–18 [?22] meters)........**savignii** (p. 235)

      d^2. Arms 38–48 in number, 105–115 mm. long; enlarged lower pinnules composed of 26–30 segments; cirri composed of 40–50 segments of which the outer bear prominent, though not especially long, dorsal spines (Queensland and Aru Islands; 0–22 [?36] meters) **nematodon** (p. 241)

    c^2. Segments of the enlarged proximal pinnules with variously modified distal ends so that the profile of these pinnules is serrate.

      d^1. Distal ends of the segments of the enlarged proximal pinnules with rounded processes, but no spines; enlarged proximal pinnules sharply prismatic and usually much stiffened, with the distal portion of the prismatic ridges on each segment produced into a rounded-triangular process so that the profiles of these pinnules are very strongly serrate, with conspicuous rounded teeth; division series and arm bases very rugged, the component ossicles swollen dorsally, with prominent synarthrial and articular tubercles; 10–30 (usually between 11 and 22) arms 70–150 mm. long; cirri very variable, with 25–46 (usually between 30 and 45) segments (from Philippines to Andamans [possibly Maldives], and southward to northern Australia; 0–111 meters)........**crenulata** (p. 253)

      d^2. Distal ends of the segments of the enlarged proximal pinnules with spines, either all around or segregated at the prismatic angles.

        e^1. Enlarged proximal pinnules stout, composed of cylindrical or only very slightly prismatic segments which have everted and spinous distal ends, and usually larger on the outer than on the inner arms of each ray; disk more or less extensively plated; 11–28 arms 50–140 mm. long; cirri with 16–38 (usually 30–35) segments (Amboina and Aru Islands; 0–20 meters)........**variipinna** (p. 278)

        e^2. Enlarged proximal pinnules slender, composed of strongly prismatic segments, which bear one or (usually) several spines at the distal prismatic angles, and the same size on all the arms; disk unplated; slender, with not more than 13 arms 50–100 mm. long.

          f^1. Cirri with 23–26 segments which from the tenth or eleventh onward are about as long as broad (Singapore and Maldive Islands; littoral)........**producta** (p. 275)

f^2. Cirri with 24–36 (usually 30–33) segments all of which are about twice as long as broad at the ends (south of eastern Borneo; 82–88 meters)----**propinqua** (p. 277)

b^2. Basal segments of the enlarged proximal pinnules with prominent thin carinate extensions or keels on the side toward the arm tip.

c^1. IIIBr series always present, all or most of them 4(3+4); brachials exceedingly short, mostly oblong; cirri with 26–45 (usually 30–35) segments, the longest never so long as broad; median dorsal tubercles or small spines are developed from the twelfth-fourteenth onward; 18–27 arms 85–150 mm. long (Andaman Islands to Kwala Cassau and Java; littoral) **philiberti** (p. 313)

c^2. IIIBr series 2, or absent.

d^1. The outer cirrus segments bear long, slender, sharp, and prominent dorsal spines which begin abruptly.

e^1. Cirri stout, with all the component segments broader than long.

f^1. Cirri very stout with all the segments much broader than long; 10–13 arms 170–180 mm. long; cirri XV, 29–30 (Maldive Islands; littoral)------------**flora** (p. 333)

f^2. Cirri less stout, the longest segments from one-third to one-half again as broad as long; 19–39 (most commonly about 30) arms, 75–85 mm. long; cirri XXI–XXXIII, 25–34 (usually about 30) (Delagoa Bay)------------------**delagoae** (p. 334)

e^2. Cirri slender or moderately stout, with the longest segments as long as, or longer than, broad.

f^1. Larger, the 11–23 arms 100–150 mm. long; brachials in the middle and outer portion of the arms more or less wedge-shaped; P_2 and P_3 composed of 25–33 segments.

g^1. Usually 35–40 cirrus segments; P_2 and P_3 with 27–33 segments; brachials in the middle and outer part of the arms distinctly wedge-shaped, with produced distal edges; distal border of radials usually with a row of small bead-like tubercles; 11–20 arms 100–150 mm. long (Malacca Strait; 0–73 meters)--**singularis** (p. 290)

g^2. Usually 27–30 cirrus segments; P_2 and P_3 with 25 segments; brachials in the outer half of the arms short and almost oblong, with the distal edges not produced; radials concealed; 19–23 arms 120–125 mm. long (Bagamoyo and Zanzibar to Waxin and from Kurrachi to Persian Gulf; 0–88 [?89] meters)--**africana** (p. 325)

f^2. Small, the 12–13 arms 70–85 mm. long; brachials in the middle and outer portions of the arms exceedingly short and discoidal; P_2 and P_3 composed of 18–25 segments; cirri with 26–35 (usually 30–35) segments, 20–23 mm. long (southern Japan) **schlegelii** (p. 329)

d^2. The outer cirrus segments bear dorsal tubercles or short, broad, and usually blunt, spines which develop very gradually.

e^1. Cirri tapering conspicuously distally so that the terminal third or fourth is only about half as broad in lateral view as the proximal portion; cirri almost smooth, with only slight and inconspicuous subterminal dorsal tubercles on the last 10–15 segments; distal cirrus segments always longer than broad, varying from slightly longer than broad to twice as long as broad; cirri long, 30–33 mm. (rather more than one-fourth the arm length); 19 arms 120 mm. long; brachials short; P_3 with 27 segments (off western Java; 24 meters)-----------------------------------**astyanax** (p. 284)

e^2. Cirri tapering not at all, or only very slightly, distally, the distal segments being never longer than broad and usually markedly broader than long, and bearing well-developed dorsal processes.

f^1. Cirri with not more than 31 segments.

g^1. Brachials exceedingly short and discoidal, with more or less strongly produced ends; 20–31 cirrus segments; 11–18 arms (Ceylon and Bay of Bengal to Philippines; 0–44 [?84] meters)------------------------------**bengalensis** (p. 321)

g^2. Brachials longer, wedge-shaped, the distal ends not produced; 15–18 arms 65–120 mm. long (Philippines to Singapore and Amboina; 0–36 meters)--**affinis** (p. 285)

f^2. Cirri with 30–44 segments.

g^1. Cirri with all the segments broader than long.

h^1. P_3 as large as, or larger than, P_2.

i^1. Longest cirri with more than 40 segments, the outer with sharp dorsal spines; smaller, the arms up to 110 mm. in length (Maldive Islands and Ceylon and western and northern coasts of Bay of Bengal as far as Akyab, Burma; 0–62 [?69] meters)---------- **reynaudi** (p. 302)

i^2. Longest cirri with less than 40 segments, the outer with dorsal tubercles or broad and usually blunt spines; larger, the arms 145–180 mm. long.

j^1. Brachials not excessively short, beyond the proximal fourth of the arms 3–4 times as broad as long; cirri stouter, the segments subequal, all markedly broader than long; dorsal surface of the ossicles of the division series and the brachials not conspicuously swollen (Kei Islands, Amboina and Singapore to Ceylon; 0–50 meters)---------- **amboinae** (p. 297)

j^2. Brachials exceedingly short and discoidal, beyond the proximal fourth of the arms 6–8 times as broad as long with almost or quite parallel ends; cirri more slender, with 30–33 segments, the earlier segments nearly as long as broad.

k^1. Dorsal surface of the ossicles of the division series, and of the brachials to near the arm tips, swollen; profile of the proximal portion of the arms strongly and roundedly serrate, the serrations pointing distally; carination of the basal segments of the earlier pinnules very slight, almost vestigial; 19 arms 145 mm. long (Amboina; about 2 meters)---------- **sarae** (p. 318)

k^2. Dorsal surface of the ossicles of the division series and brachials not swollen; profile of the proximal portion of the arms angularly serrate, the serrations pointing proximally; dorsal profile of arms beyond the proximal third smooth; carination of the basal segments of the earlier pinnules conspicuous, though not exaggerated; 10–16 arms 100–150 mm. long (Philippines; 38–44 meters)---------- **parilis** (p. 319)

h^2. P_3 much smaller than P_2.

i^1. Cirri with 32–36 segments; 14 arms about 160 mm. long; P_2 with 30 segments (Red Sea)---------- **ater** (p. 311)

i^2. Cirri with 39–43 segments; 20 arms 80 mm. long; P_2 with 21 segments (Zanzibar)---------- **joubini** (p. 312)

g^2. Cirri with the longest segments longer than, or at least as long as, broad.

h^1. Longest cirri with 36–39 segments.

i^1. Outer cirrus segments only slightly broader than long; P_2 only very slightly longer than P_1 and resembling it, but with a few less (25) segments which become more elongate distally; P_3 the largest and longest pinnule, slightly stouter throughout than P_2, with 22 segments; 24 arms about 85 mm. long (Burma eastward to Philippines; 27–73 [?89] meters)----- **pulchra** (p. 287)

i^2. Outer cirrus segments about twice as broad as long; P_2 half again as long as P_1, slender and flagellate distally, with 24 segments; P_3 slightly smaller than P_2, but much larger than P_1; 19 arms 80 mm. long (Zanzibar)- **gravieri** (p. 289)

h^2. Longest cirri with 31–36 segments.

i^1. Outer cirrus segments from half again to twice as broad as long; P_1 and P_2 similar and of the same length, 13 mm. long with 26 segments; P_3 shorter, 9 mm. long with 19 segments; 16–25 arms 110 mm. long (Pedro shoal, off the west coast of India)---------- **compta** (p. 293)

i^2. Outer cirrus segments scarcely broader than long; P_1 10 mm. long with 26–28 segments; P_2 longer, 12 mm. long with 27 segments, and somewhat stouter; P_3 similar to P_2 but very slightly larger and longer; 13–18 arms 65–130 mm. long (Madagascar)---------- **madagascarensis** (p. 295)

ALTERNATIVE KEY TO THE SPECIES IN THE GENUS HETEROMETRA

a^1. Brachials distinctly wedge-shaped, the ends never quite parallel, those in the proximal portion of the arms (except for the first few) very obliquely wedge-shaped and sometimes triangular.

b^1. Outer cirrus segments smooth dorsally, with or without a slight median carination, but never with dorsal spines or tubercles; 25–36 (usually about 30) cirrus segments; 16–26 arms 60–145 mm. long (from Philippines to Andaman Islands; 0–80 meters) **quinduplicava** (p. 245)

b^2. Outer cirrus segments bearing spines or tubercles dorsally.

c^1. Cirri tapering conspicuously distally so that the terminal third or fourth is only about half as broad in lateral view as the proximal portion; cirri almost smooth, the last 10–15 segments with only slight and inconspicuous dorsal tubercles; distal cirrus segments always longer than broad, varying from slightly longer than broad to twice as long as broad.

d^1. Enlarged lower pinnules smooth, the segments with unmodified distal ends; P_3 the largest and longest pinnule, 19 mm. long with 27 segments; cirri 30–33 mm. long with 37–39 segments; 19 arms 120 mm. long (off western Java; 24 meters) - **astyanax** (p. 284)

d^2. Enlarged lower pinnules with the distal angles of the component segments slightly swollen and produced; P_2 the longest pinnule, 10.5 mm. long with 17 segments; cirri usually about 30 mm. long with usually 30–33 segments; 10–13 (usually 11–13) arms 90–120 mm. long (south of eastern Borneo; 82–88 meters) - **propinqua** (p. 277)

c^2. Cirri tapering not at all, or only very slightly, distally, the distal segments being never longer than broad and usually markedly broader than long, and bearing well developed dorsal processes.

d^1. Enlarged proximal pinnules slender and smooth, their basal segments without carinate processes on the side toward the arm tip, and their outer segments with smooth and unmodified distal ends.

e^1. Usually 20 arms, up to 150 mm. in length; enlarged lower pinnules very long and slender, composed of about 20 segments; cirri with 23–33 (usually 25–30) segments of which the outer bear long dorsal spines (Red Sea and eastward to Muscat; 0–18 [?22] meters) -- **savignii** (p. 235)

e^2. Arms 38–48 in number, 105–115 mm. long; enlarged lower pinnules composed of 26–30 segments; cirri composed of 40–50 segments of which the outer bear prominent, though not especially long, dorsal spines (Queensland and Aru Islands; 0–22 [?36] meters) -- **nematodon** (p. 241)

d^2. Enlarged proximal pinnules with the basal segments carinate on the side toward the arm tip, or with the outer segments bearing fine spines or other processes on the distal ends.

e^1. Enlarged proximal pinnules smooth, a few of the basal segments bearing carinate processes on the side toward the arm tip.

f^1. Longest cirri with not more than 30 segments; 15–18 arms 65–120 mm. long (Philippines to Singapore and Amboina; 0–36 meters) ------------- **affinis** (p. 285)

f^2. Longest cirri with 30–40 segments.

g^1. Cirri with all the segments broader than long.

h^1. P_3 as large as, or larger than, P_2.

i^1. Longest cirri with more than 40 segments, the outer with sharp dorsal spines; arms up to 110 mm. in length (Maldive Islands and Ceylon and western and northern coasts of Bay of Bengal as far as Akyab, Burma; 0–62 [?69] meters) -- **reynaudi** (p. 302)

i^2. Longest cirri with less than 40 segments, the outer with dorsal tubercles or broad and usually blunt spines; larger, the arms 145–180 mm. long (Kei Islands, Amboina and Singapore to Ceylon; 0–50 meters) - **amboinae** (p. 297)

h^2. P_3 much smaller than P_2

i^1. Cirri with 32–36 segments; 14 arms about 160 mm. long; P_2 with 30 segments (Red Sea) -- **ater** (p. 311)

i^2. Cirri with 39–43 segments; 20 arms 80 mm. long; P_2 with 21 segments (Zanzibar) ---------- **joubini** (p. 312)

g^2. Cirri with the longest segments longer than, or at least as long as, broad.

h^1. Longest cirri with 36–39 segments.

i^1. Outer cirrus segments only slightly broader than long.

j^1. P_2 only very slightly longer than P_1 and resembling it but with a few less (25) segments which become more elongate distally; P_3 the largest and longest pinnule, slightly stouter throughout than P_2, with 22 segments; 24 arms about 85 mm. long (from Burma eastward to the Philippines; 27–73 [?89] meters) ---------- **pulchra** (p. 287)

j^2. P_2 much longer than P_1 with about the same number (33–34) of segments; P_3 much shorter than P_2, equaling P_1 in length, with 27 segments; 11–20 arms 100–150 mm. long (Malacca Strait; 0–73 meters) - **singularis** (p. 290)

i^2. Outer cirrus segments about twice as broad as long; P_2 half again as long as P_1, slender and flagellate distally, with 24 segments; P_3 slightly smaller than P_2, but much larger than P_1; 19 arms 80 mm. long (Zanzibar) - **gravieri** (p. 289)

h^2. Longest cirri with 31–36 segments.

i^1. Outer cirrus segments from half again to twice as broad as long; P_1 and P_2 similar and of the same length, 13 mm. long with 26 segments; P_3 shorter, 9 mm. long with 19 segments; 16–25 arms 110 mm. long (Pedro shoal, off west coast of India) ---------- **compta** (p. 293)

i^2. Outer cirrus segments scarcely broader than long; P_1 10 mm. long with 26–28 segments; P_2 longer, 12 mm. long with 27 segments, and somewhat stouter; P_3 similar to P_2 but very slightly larger and longer; 13–18 arms 65–130 mm. long (Madagascar) ---------- **madagascarensis** (p. 295)

e^2. Enlarged proximal pinnules with a serrate profile, the distal ends of the component segments armed with spines or bearing high keel-like processes on the outer ends of the prismatic ridges.

f^1. Enlarged proximal pinnules stout, composed of cylindrical or only very slightly prismatic segments which have everted and spinuos distal ends; disk more or less extensively plated; 11–28 arms 50–140 mm. long; cirri with 16–38 (usually 30–35) segments (Amboina and the Aru Islands; 0–20 meters) ---- **variipinna** (p. 278)

f^2. Enlarged proximal pinnules sharply prismatic, with the distal portion of the prismatic ridges on each segment extended outward in the form of high thin rounded-triangular processes or broad blunt teeth.

g^1. Segments of the enlarged proximal pinnules with the distal portion of the prismatic ridges produced into a high thin rounded-triangular process, so that the profiles of these pinnules are very strongly serrate with conspicuous rounded teeth; division series and arm bases very rugged, the component ossicles swollen dorsally, with prominent though rather broadly rounded synarthrial and articular tubercles; 10–30 (usually between 11 and 22) arms 70–150 mm. long; cirri very variable, with 25–46 (usually between 30 and 45) segments (from Philippines to Andamans [possibly Maldives] and southward to northern Australia; 0–111 meters) ---------- **crenulata** (p. 253)

g^2. Enlarged lower pinnules rather slender, becoming flagellate distally, the basal segments sharply carinate and the segments from the third outward with the entire distal edge somewhat produced and overlapping, the outer portion of the prismatic ridges being produced into a blunt spine, which is directed obliquely forward; cirri slender, 15 mm. long with 23–26 segments; 10–13 arms 50 mm. long (Singapore to Maldive Islands; littoral) ---------- **producta** (p. 275)

a^2. Brachials beyond the proximal fourth of the arms exceedingly short, discoidal, with the ends parallel, the brachials within the proximal fourth of the arms also exceedingly short, with parallel or slightly oblique ends.

b^1. IIIBr series present, all or mostly 4 (3+4); 18–27 arms (Andaman Islands to Kwala Cassan and Java; littoral) ---------- **philiberti** (p. 313)

b^2. IIIBr series absent, or if present all or mostly 2.
  c^1. Longest proximal cirrus segments about as long as broad—sometimes slightly broader than long or slightly longer than broad.
    d^1. Longest cirri, in fully grown individuals, with more than 30 segments.
      e^1. Larger, with 10–19 arms 100–150 mm. long.
        f^1. Outer cirrus segments with small carinate dorsal spines which develop gradually; proximal portion of the arms with a distinctly serrate profile.
          g^1. Profile of the proximal portion of the arms strongly and roundedly serrate, the serrations pointing distally; carination of the basal segments of the earlier pinnules very slight, almost vestigial; 19 arms 145 mm. long (Amboina; about 2 meters)----------**sarae** (p. 318)
          g^2. Profile of the proximal portion of the arms angularly serrate, the serrations pointing proximally; dorsal profile of arms beyond the proximal third smooth; carination of the basal segments of the earlier pinnules conspicuous, though not exaggerated; 10–16 arms 100–150 mm. long (Philippines; 38–44 meters)----**parilis** (p. 319)
        f^2. Outer cirrus segments with long and prominent dorsal spines, which begin abruptly; elements of the division series and earlier brachials with the dorsal surface unmodified (Bagamoyo and Zanzibar to Waxin and from Kurrachi to Persian Gulf; 0–88 [?89] meters)----------**africana** (p. 325)
      e^2. Small and delicate, with 12–13 arms 70–85 mm. long (southern Japan)-**schlegelii** (p. 329)
    d^2. Longest cirri with never more than 31, and usually much less than 30 segments; distal or proximal ends of the earlier brachials produced (Ceylon and Bay of Bengal to Philippines; 0–44 [?84] meters)----------**bengalensis** (p. 321)
  c^2. All the cirrus segments much broader than long, the longest proximal segments being one-third to one-half again as broad as long.
    d^1. Cirri very stout and strongly curved, with 29–30 segments; 10–13 arms 170–180 mm. long (Maldive Islands)---------- **flora** (p. 333)
    d^2. Cirri less stout and less strongly curved, with usually about 30 segments; 19–39 (most commonly about 30) arms 75–85 mm. long (Delagoa Bay)----------**delagoae** (p. 334)

HETEROMETRA SAVIGNII (J. Müller)

Plate 21, Figures 82–84; Plate 22, Figures 85–88

[See also vol. 1, pt. 2, figs. 440, 441 (pinnule tips), p. 261.]

Comatula multiradiata Audouin, *in* Savigny, Description de l'Égypte, 1817 (1826), p. 205, pl. 1, fig. I, 1–6 (Red Sea).—Leuckart, Isis, vol. 5, 1839, p. 612 (myzostomes).—Leuckart, Bruchstüke III, Helminthol. Beiträge, Programm zur Eröffnung der Wintervorlesungen in Freiburg, 1842, pt. 1, p. 8 (myzostomes).—von Graff, Das Genus *Myzostoma*, 1877, pp. 2, 22 (myzostomes); *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, p. 32 (myzostomes).—Braun, Centralbl. für Bakteriol. und Parasitenk., vol. 3, 1888, p. 183 (myzostomes).—A. H. Clark, Amer. Nat., vol. 43, 1909, p. 265 (recorded by Audouin from Red Sea in 1817; identified by J. Müller as [*Heterometra*] *savignii*); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 1 (of Audouin, in Savigny; history of confusion by de Blainville with *Comatula* [*Oligometrides*] *adeonae*), p. 2 (identified as *savignii* by J. Müller), p. 2 (of Leuckart; identified as *savignii* by P. H. Carpenter [in von Graff]); Crinoids of the Indian Ocean, 1912, p. 2 (identity).

Comatula sp. Leuckart, Zeitschr. für organ. Physik, vol. 3, Heft 4, 1833, p. 387 (from Audouin, in Savigny).

Comatula adeonae de Blainville, Manuel d'actinologie, 1834 (1836), pl. 26, figs. 1–5 [but not p. 249] (after Audouin).—[Anonymous], Penny encyclopedia, vol. 7, 1837, p. 391 (figure, but not description; from de Blainville).—[Knight], Natural history, or Second division of the English encyclopedia, vol. 2, 1867, p. 99 (same).

Alecto savignii J. Müller, Monatsber. preuss. Akad. Wiss., 1841, p. 185 (description; Red Sea).—J. Müller, Archiv für Naturg., 1841, vol. 1, p. 144 (same); Abh. preuss. Akad. Wiss., 1841 (1843), p. 181.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 453 (commonly emended to "*savignyi*"); Amer. Nat., vol. 43, 1909, p. 254 (history); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 2 (history; synonymy); vol. 43, 1912, p. 383 (identity).

Comatula (*Alecto*) *savignii* J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 257 (detailed description; Red Sea).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 30 (identity).

Comatula savignyi Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 203 (synonymy; description; coasts of Egypt).—von Martens, Von der Decken's Reise in Ost-Africa, vol. 3, 1869, p. 129 (Red Sea).

Antedon savignii P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 23 (arm structure), p. 29 (listed as an *Antedon*).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula).

Antedon savignyi Ludwig, *in* Kossman, Reise nach dem Rothen Meer, vol. 5, Echinoderma, 1880, p. 4 (Red Sea; no definite locality).—von Graff, *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, p. 13 (myzostomes).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 55, 252, 253, 255, 263, 366, 380 (discussion; Red Sea; Muscat [Kurrachee refers to *H. africana*]).—Hartlaub, Nova Acta Acad. German, vol. 58, No. 1, 1891, p. 17 (in key), p. 19 (notes on one of the cotypes), p. 47 (compared with *A. klunzingeri* [*Lamprometra palmata*]), pl. 2, fig. 20 (drawn from a cotype), p. 113 (in Göttingen Mus.).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—Chadwick, Journ. Linn. Soc. (Zool.), vol. 31, 1908, p. 47 (Suez Bay, 4 fathoms; Ul Shubuk, 9 fathoms; Khor Shinab, 10–12 fathoms; Salaka; characters; color in life; commensal ophiurans).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 5 (recorded by Chadwick from the Red Sea; identity); Crinoids of the Indian Ocean, 1912, pp. 35, 41 (identity).—Boulenger, Proc. Zool. Soc. London, 1913, pp. 88, 102 (Ul Shubuk, 9 fathoms; myzostomes).

Himerometra savignii A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Heterometra sovignii A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 11 (listed); Amer. Nat., vol. 43, 1909, p. 254 (history; range), p. 255 (reported by Chadwick from Red Sea); Vid. Medd. Naturh. Foren. København, 1909, p. 164 (compared with *H. singularis*); Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 2, 5, 9, 14, 24 (history; synonymy; localities [record from Kurrachi is *H. africana*]); Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 251 (Muscat); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 26 (division series compared with those of *Petasometra helianthoides*).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 381 (cotype in U. S. N. M.), p. 383 (identity; original specimens include 1 of *Craspedometra* [*Heterometra*] *ater*), p. 394 (localities; notes); Crinoids of the Indian Ocean, 1912, pp. 2, 30, 35, 41 (identity), p. 124 (synonymy; localities [specimens from Kurrachi and Straits of Ormuz, and the notes, refer to *H. africana*]); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 27 (published reference to specimens in B. M.; localities; notes; specimens from Kurrachi are *H. africana*).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76 (in key; range [except Persian Gulf and Kurrachi, which refer to *H. africana*]).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 48.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 99 (range), p. 104.

Heterometra savignyii Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnostic features.—The enlarged proximal pinnules are very long, slender, and perfectly smooth, without carinate processes on the earlier segments. There are usually 20 arms up to 150 mm. in length, which are composed of wedge-shaped brachials. The cirri have usually 25–30 segments of which the outer bear long and prominent dorsal spines.

Description.—The centrodorsal is discoidal, moderately thick, with a flat dorsal pole 3 mm. in diameter. The cirrus sockets are arranged in two and a partial third alternating marginal rows.

The cirri are XV–XXX (usually about XX), 23–35 (usually 26–33), 15–22 (usually about 20) mm. long. Dorsal spines, usually long, slender, and prominent, are developed from about the twelfth segment onward.

There are no basal rays.

The radials are usually even with the rim of the centrodorsal in the midradial line and visible as low triangles in the interradial angles. The IBr_1 are short, slightly over three times as broad as long, with the lateral borders nearly straight and parallel. They are united in the proximal half but are separated in the distal half by a moderately broad U-shaped gap. The IBr_2 (axillaries) are broadly pentagonal, twice as broad as long. There are usually 10 IIBr 4(3+4) series present; exceptionally IIBr 2 series occur. IIIBr 2 series are sometimes present. The division series are well rounded dorsally and well separated laterally, the sides perfectly smooth with no trace of lateral production.

The 13–21 (usually 20) arms are 90–150 mm. long in fully developed individuals. The brachials are smooth.

Syzygies occur between brachials 3+4, again from between brachials 9+10 to between brachials 21+22 (usually about brachials 19+20), and distally at intervals of 4–14 muscular articulations.

P_D is stout basally, but tapers rapidly, becoming very slender distally. P_1 is larger and stouter than P_D and tapers less rapidly. P_2 is similar to P_1. P_3 is sometimes large and long, like the pinnules preceding. The lower pinnules are very long but slender and perfectly smooth.

Notes.—Müller's original description, which was based on the specimens from the Red Sea collected by Hemprich and Ehrenberg, is as follows: The cirri are XXX, 24–29; the outermost 12–14 segments bear a process on the dorsal side. The radials are visible. The IIBr series are 4(3+4). In the next division the axillary has no syzygy. The 20 arms are up to 150 mm. in length. The second ossicle beyond the radial (IBr) axillary can be rocked from side to side on the first (which means that there is a synarthry between the first two ossicles beyond the IBr axillary). The brachials are smooth. The intersyzygial interval is 4 to 9 muscular articulations. The first pinnule is on the second segment after either the first or the second arm division. The second and third pinnules are the largest, and sometimes the fourth is also large. The first pinnule is thick basally but tapers rapidly and is not so long as the second. The skin of the disk is soft. The color in alcohol is yellowish brown. Müller gave the size as up to one foot, which would mean an arm length of 150 mm.

Carpenter examined Müller's specimens in the Berlin Museum, and in his key to the species in the *Savignyi* group published in the *Challenger* report (1888) he added some features to those given by Müller. He noted that IIIBr 2 series may or may not be present. There are no lateral processes on the segments of the lower pinnules. The cirri are XXV–XXX, between 25 and 35, and the later cirrus segments have strong spines. The second syzygy is between about brachials 19+20. P_D is smaller than P_1.

Hartlaub gave an excellent figure of one of Müller's original specimens, which the museum at Göttingen received in exchange from the Berlin Museum. He noted that this species does not always have as many as 20 arms, and that a second specimen from Müller's material at Göttingen has not more than 13 arms.

In one of Müller's specimens in the Berlin Museum that I examined the centrodorsal is discoidal, moderately thick, with a flat dorsal pole 3 mm. in diameter. The cirrus sockets are arranged in two and a partial third alternating marginal rows. The cirri are about 20 mm. long and composed of 23–25 segments; but the best-developed cirri are all broken off. Long and prominent dorsal spines are developed from the twelfth segment onward. No basal rays are visible. The radials are even with the rim of the centrodorsal in the midradial line, and are slightly visible as low triangles in the interradial angles. The IBr_1 are slightly over three times as broad as long with the lateral edges nearly straight and parallel, united in the proximal half but separated in the distal half by a moderately broad U-shaped gap. The IBr_2 are broadly pentagonal and twice as broad as long. The division series are well rounded dorsally and well separated laterally, the sides being perfectly smooth with no trace of lateral production. There are 20 arms 125 mm. long. Ten IIBr 4(3+4) series are present. The lower pinnules are very long but are slender and perfectly smooth.

Two other specimens in the Berlin Museum examined by Müller have 20 arms each, 10 IIBr 4(3+4) series being present in both cases. They resemble the one just described.

Carpenter's note that IIIBr 2 series may or may not be present was not based upon any specimens seen by Müller, for all the specimens known to Müller with the exception of the one mentioned by Hartlaub with 13 arms, the one figured by Hartlaub, which has 18 arms, and the type of *H. ater*, which Müller did not distinguish from *H. savignii* (see page 311) with 14 arms, had exactly 20 arms, and none of them had any IIIBr series at all. The specimens possessing IIIBr series known to Carpenter were those in the British Museum from Kurrachi, which are representatives not of *H. savignii* but of the quite different *H. africana*.

Dujardin, in Dujardin and Hupé, in his account of *Comatula savignyi* did not follow his usual procedure of simply translating Müller's description but wrote one of his own. He said the expanse is 90 mm. There are 20 branches or tertiary arms carrying numerous pinnules of almost equal length, giving the arms a feathery appearance. The cirri are XXX, 29–30; the last segment is clawed, and the 7 or 9 preceding bear a small spine. The habitat is given as the coasts of Egypt. This description was not drawn up from any specimens but from the original figures published by Savigny in 1817 and reproduced by de Blainville in 1836. While in the heading the species is credited to J. Müller, no reference is given to his descriptions. The only references given are to Savigny's plate, to Audouin's explanation of this plate, and to de Blainville's description and plate of *Comatula adeonae*. Dujardin's short description accords perfectly with these figures in the size, number of arms, number of cirri, and number of cirrus segments given, while the figures afford no indication of the presence of elongated proximal pinnules, nor of the number of the elements in the division series. The locality given is to be inferred from the inclusion of the species in Savigny's work, and the identity of the species delineated by Savigny was made clear by Müller in 1841 and again in 1849.

Both the of specimens from the Gulf of Suez in the British Museum are small.

The two specimens recorded by Chadwick from Suez Bay in 7 meters have 13 arms. In both, syzygies occur between brachials 3+4 and 9+10 and distally at irregular intervals of 5 to 14 muscular articulations. The color in alcohol is purple with purplish white cirri and almost white pinnules.

The single specimen recorded from Ul Shubuk by Chadwick had 20 arms, 10 IIBr 4(3+4) series being present. The position of the second syzygy varies from between brachials 17+18 to between brachials 21+22, and the distal intersyzygial interval is 11 to 13 muscular articulations. This specimen was serving as host to no less than 15 ophiurans (see Part 2, p. 645).

The single specimen from Salaka has 20 arms. Like one of those from Khor Shinab its color when living was brown and white.

Of the two specimens from Khor Shinab one has 14 and the other 18 arms. The second syzygy is in some cases between brachials 15+16, but usually it varies in position from between brachials 18+19 to between brachials 20+21, and others follow at intervals of 8 to 10 muscular articulations. When living one was brown and white and the other was purple and white.

In the specimen in the Paris Museum from Muscat the dorsal spines on the outer cirrus segments are very sharp. This suggests that this specimen may represent *H. africana* instead of *H. savignii.* When I examined it I did not question Carpenter's earlier determination.

Remarks.—The chief characteristics of this species are the strongly rounded and well-separated postradial series and division series, which do not have produced margins; the very long and slender, perfectly smooth, and evenly tapering P_2 and P_3; and the long and slender spines on the outer cirrus segments. Nearly all individuals have exactly 20 arms, 10 IIBr 4(3+4) series being present.

Localities.—Red Sea; Egyptian coast [Audouin, in Savigny, 1826; Leuckart, 1833, 1839, 1842; de Blainville, 1836; Anonymous, 1837; J. Müller, 1841, 1849; Dujardin and Hupé, 1862; Knight, 1867; Ludwig, 1880; A. H. Clark, 1907, 1908, 1909, 1911, 1912, 1918].

Red Sea; Hemprich and Ehrenberg [Leuckart, 1839, 1842; J. Müller, 1841, 1843, 1849; von Graff, 1877, 1884; Dujardin and Hupé, 1862; P. H. Carpenter, 1879, 1883, 1884, 1888; Ludwig, 1880; Bell, 1882; Braun, 1888; Hartlaub, 1891; A. H. Clark, 1907, 1908, 1909, 1911, 1912, 1918] (3, U.S.N.M., 35213; Berl. Mus., 1054, 1056).

Red Sea; Count von der Decken [von Martens, 1869].

Gulf of Suez [A. H. Clark, 1912, 1913] (2, B.M.).

Suez Bay; 7 meters [Chadwick, 1908; A. H. Clark, 1911].

Tor, Red Sea [A. H. Clark, 1911, 1912] (1, Mus. f. Meereskunde, Berlin).

Ul Shubuk; 16 meters; muddy bottom [Chadwick, 1908; A. H. Clark, 1911, 1912; Boulenger, 1913].

Salaka; at the anchorage, among corals [Chadwick, 1908; A. H. Clark, 1911, 1912].

Khor Shinab; 18–22 meters [Chadwick, 1908; A. H. Clark, 1911, 1912] (1, U.S.N.M., 35081).

Muscat; M. de Rousseau, 1841 [P. H. Carpenter, 1888; A. H. Clark, 1911, 1912] (1, P.M.).

No locality [A. H. Clark, 1912] (1, Berl. M., 5371).

Geographical range.—Red Sea and eastward to Muscat.

Bathymetrical range.—From the shoreline down to 18 (?22) meters. Most of the records are from the shoreline or from very shallow water.

History.—This species was first made known through the excellent figures published by M. Savigny in 1826 and identified in the explanation of the plate as *Comatula multiradiata.* The species represented was referred to in 1833 by Professor Leuckart as *Comatula* sp.; but later, in 1839 and 1842, he accepted Audouin's determination and called it *Comatula multiradiata.*

In 1836 M. de Blainville reproduced Savigny's figures but in some unexplained way used them as illustrating Lamarck's *Comatula adeonae* (= *Oligometrides adeonae*), a 10-armed species. His reproduction of these figures, together with his identification of them, was incorporated in the Penny Encyclopedia in 1837, and in the Natural History, or Second Division of the English Encyclopedia, in 1867.

Prof. Johannes Müller was unable to identify the species figured by Savigny with any form known to him, so in 1841 he proposed the new name *Alecto savignii* for the animal represented by Savigny in figure 1 on plate 1. Müller gave no description, merely stating that it possessed 20 arms.

Hemprich and Ehrenberg had brought back from the Red Sea a number of specimens of this species, and from them Professor Leuckart took some myzostomes, which he recorded in 1839 and 1842, calling the host *Comatula multiradiata.* His record was republished by von Graff in 1877 and 1844, and by Braun in 1888.

Müller studied the specimens that had been brought to Berlin by Hemprich and Ehrenberg and in 1849 published a description of them under the name of *Comatula* (*Alecto*) *savignii,* again referring Savigny's plate 1, figure 1.

Departing from his usual custom of simply translating Müller's descriptions, Dujardin, in Dujardin and Hupé, 1862, drew up an original description of *Comatula savignyi* J. Müller, which was prepared not from any specimens but from Savigny's figures as reproduced by de Blainville. Although he credited the species to Müller, the only references he gave were to Savigny's plate, to Audouin's explanation of the figures on the plate, and to de Blainville's text and plate. He saw the curious error that de Blainville had made and placed his *Comatula adeonae* without comment in the synonymy of *Comatula savignyi.* Dujardin gave as the habitat of *Comatula savignyi* the coasts of Egypt, which was a natural inference from the inclusion of the species in Savigny's work.

In 1869 this species was mentioned as found in the Red Sea by Professor von Martens in his account of the animals collected on Count von der Decken's journey in East Africa.

Dr. P. H. Carpenter in 1879 included *Antedon savignyi* in the list of species that he was able definitely to place in the genus *Antedon* as he understood it.

It was again mentioned as occurring in the Red Sea by Prof. Hubert Ludwig in 1880.

In October 1882, Prof. F. Jeffrey Bell proposed a specific formula for this species, which was emended by Dr. P. H. Carpenter in April of the following year.

In his discussion of *Antedon adeonae* in the *Alert* report published in 1884 Prof. F. Jeffrey Bell wrote:

> There is a curious error in connexion with this species which does not seem to have been noticed. Lamarck described it as "*C. radiis pinnatis denis* &c.:" de Blainville, while quoting Lamarck, refers also to his own figures in his 'Atlas' (pl. xxvi); in this reference he is followed by J. Müller and by the editors of the second edition of Lamarck. The figures, however, when referred to are seen to be those of a species with twenty arms and with cirri nearer thirty than twenty. It is not perhaps necessary at this distance of time to waste time in inquiring what species it is that de Blainville has there figured.

In the *Challenger* report published in 1888 Dr. P. H. Carpenter, who had examined in Berlin the specimens collected by Hemprich and Ehrenberg and described by Müller, and also other specimens in the British and Paris Museums, gave some additional information regarding this species in the form of notes incorporated in the key to the species of the *Savignyi* group of *Antedon*. He said that in addition to being found in the Red Sea it also occurs at Muscat and Kurrachi but is not known to extend farther eastward. The first locality was represented by a specimen in the Paris Museum and the second by specimens in the British Museum, although he did not mention this. The specimens from Kurrachi represent *H. africana*, and there is a possibility that the specimen from Muscat also represents that species.

Dr. Clemens Hartlaub in 1891 gave an excellent figure of one of Müller's original specimens which had been received in exchange by the Göttingen Museum, and mentioned another of Müller's original specimens which was already in that Museum.

In my first revision of the old genus *Antedon* published in 1907, this species was referred to the new genus *Himerometra*.

Herbert C. Chadwick in 1908 recorded this species from Suez Bay, Ul Shubuk, and Khor Shinab, giving the essential characters of his specimens and the color in life, and mentioning the commensal ophiurans.

In a review of the family Himerometridae published in 1909 I transferred this species to the new genus *Heterometra*.

In a paper on the crinoids of the Paris Museum published in 1911 I recorded a specimen from Muscat and gave a partial description of it. This is the specimen upon which P. H. Carpenter based his mention of Muscat as a locality for the species in 1888. In a paper on the crinoids of the coasts of Africa published in the same year Tor was added to the known localities for this species, on the basis of a specimen in the Museum für Meereskunde in Berlin.

In my memoir on the crinoids of the Indian Ocean published in 1912 I recorded and described one specimen from Kurrachi and seven from the Straits of Ormuz and also gave a summary of all the known localities. Reexamination of these eight specimens disclosed the fact that the basal segments of the proximal pinnules bear high carinate processes, and further study has shown that they are representatives of *H. africana*.

In a paper on the crinoids of the Berlin Museum published in the same year I described at considerable length three of Hemprich and Ehrenberg's specimens from the Red Sea, one from Tor in the Museum für Meereskunde and one without locality.

In 1913 in a paper on the crinoids of the British Museum I recorded two small specimens from the Gulf of Suez and described seven from Kurrachi. These last, which represent not *H. savignii* but *H. africana*, had previously been examined by P. H. Carpenter, and the mention of Kurrachi as a locality for this species in the *Challenger* report is based upon them. In the same year Boulenger described the myzostomes from the specimen from Ul Shubuk recorded in 1908 by Chadwick.

HETEROMETRA NEMATODON (Hartlaub)

PLATE 28, FIGURE 117

Antedon milberti (part) BELL, Report Zool. Coll. H. M. S. *Alert*, 1884, p. 156 (Port Molle, 12–20 fathoms).—A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 23 (identity).

Antedon nematodon HARTLAUB, Nachr. Ges. Göttingen, May 1890, p. 185 (description; Bowen, Queensland).—HARTLAUB, Nova Acta Acad. German, vol. 58, No. 1, 1891, p. 19 (in key), p. 27 (detailed description and comparisons; Bowen), pl. 1, fig. 9.—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed), pl. 12, fig. 6 (from Hartlaub).—A. H. CLARK, Vid. Medd. Nat. Foren. København, 1909, p. 117 (identity); Mem. Australian Mus., vol. 4, 1911, p. 718 (identity); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity); Crinoids of the Indian Ocean, 1912, p. 37 (identity).

Himerometra nematodon A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Heterometra nematodon A. H. CLARK, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 441 (Australian tropical species occurring south to Port Molle), p. 443 (range on the east coast); Mem. Australian Mus., vol. 4, 1911, p. 718 (identity), p. 721 (occurs south to Bowen), p. 734 (in key), p. 768 (synonymy; characters; Australian record; Port Molle, *Alert*); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 120 (synonymy; localities).—REICHENSPERGER, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 82 (Aru Islands), p. 101 (localities; notes).—A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76 (in key; range).—H. L. CLARK, The echinoderm fauna of Torres Strait, 1921, p. 192 (distribution).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 27, 30.

Amphimetra nematodon A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity), p. 15 (detailed description of the type; Bowen), p. 16 (compared with *A.* [*Heterometra*] *philiberti*); vol. 61, No. 15, 1913, p. 23 (published reference to specimen in B. M.; Port Molle, 12–20 fathoms); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, pp. 224 ff. (detailed account of distribution in Australia).

Diagnostic features.—The enlarged proximal pinnules are slender and smooth, without carinate processes on the basal segments, and are composed of 26–30 segments. P_1, P_2, and P_3 are of about the same size, or P_1 is the longest and P_3 the shortest, but P_1 is always larger than P_D. The cirri are 25–30 mm. long and are composed of 40–50 segments, which are subequal, the outer bearing prominent, though not especially long, dorsal spines. The 27–48 arms are 105–115 mm. long.

Description.—The centrodorsal is a thick convex disk with the cirri arranged in two and a partial third irregular rows.

The cirri are about XXX, 40–50, about 25 mm. long. The segments are approximately similar, none of them being longer than broad. In the distal two-thirds, or at the least in the distal half, of the cirri the segments bear rather strong dorsal spines. The cirri are rather strongly compressed laterally at their ends.

The radials are not visible. The IBr_1 are very short, and are entirely free laterally. The IBr_2 (axillaries) are almost triangular and are also very short. The IIBr series are 4 (3+4), exceptionally 2. The IIIBr series are 2, but 4 (3+4) when following IIBr 2 series. The IVBr series are 2, but only a few are present. The elements of the IIBr and subsequent series are, when compared with the elements of the IBr series, rather long. The first ossicles following an axillary are almost entirely united interiorly.

The 38 arms are more than 80 mm. long. They are composed of short discoidal brachials the distal ends of which are rather strongly produced, and which in the proximal third of the arms overlap somewhat laterally. Only the basal brachials have smooth ends. The arms are somewhat compressed with a narrow dorsal surface.

The first syzygy occurs between brachials 3+4, and the second from brachials 23+24 onward, often about brachials 31+32, but also further on, about brachials 41+42. The distal intersyzygial interval is 13 to 21 muscular articulations.

In general the proximal pinnules are of delicate structure and are composed of smooth cylindrical segments. P_D is about 12 mm. long and is composed of about 25 segments of which the basal are moderately thick, those in the distal half are very slender and become toward the end of the pinnule somewhat longer than broad. The segments are dark in the middle with light-colored ends. P_1 is similar in appearance, about 14 mm. long, and is composed of about 30 segments. It tapers somewhat more gradually than P_D. P_a is very small. The pinnules following P_1 decrease rather abruptly in length to about the thirteenth brachial (P_6) and then gradually become longer again, reaching a length of about 10 mm.

The disk is about 15 mm. in diameter and is deeply incised. In the general dark color of the animal the sacculi are not conspicuous.

The color is blackish brown.

Notes.—The preceding description is that given by Hartlaub. My notes on the type specimen are as follows: Two cirri still attached to the centrodorsal have 42 and 43 segments of which the twelfth and following bear dorsal spines. The longest cirrus segments are not quite so long as broad. In the outer two-thirds, or at least one-half, of the cirri the segments are twice as broad as long. The dorsal spines are rather small and slender, though sharp and prominent. The division series are narrow and rather widely separated. There are 38 arms about 105 mm. long. The brachials are extremely short and discoidal, with produced distal edges. The enlarged proximal pinnules are comparatively slender, and are smooth, not carinate. I remarked that this species appears to be most closely related to *H. philiberti* but that it is very easily distinguished from that form by the absence of carination on the proximal pinnules and by having the IIIBr series 2 instead of 4 (3+4).

The specimen dredged by the *Alert* at Port Molle is small.

Reichensperger says that the specimen from Dr. H. Merton's station 11 in the Aru Islands agrees almost completely with Hartlaub's description, but it is somewhat larger than the type. The cirri are XXXIII, 40, up to 30 mm. long. All the cirrus segments are longer than broad. Toward the end the cirri become laterally compressed, and from the twelfth to the eighteenth onward the segments bear sharp and prominent dorsal spines. The radials are concealed. The IBr_1 are free laterally. In the division series the strong preponderance of series with two elements is characteristic. He gives two examples of arm division. On one of these there are two IIBr 4 (3+4) series; one of the latter bears two IIIBr 2 series and a single IVBr 2 series, while the other bears a IIIBr 2 series externally and a IIIBr 4 (3+4) series internally, the latter carrying two IVBr 2 series. In the other example there are two IIBr 4 (3+4) series and four IIIBr 2 series, beyond which there are four IVBr series, the two outer 4 (3+4) and the two inner 2. The 48 arms are 115 mm. long. The first ossicles following each axillary are almost entirely united laterally the result being that the arms are rather close together and often are almost parallel to each other. The dorsal arm sculpture is as figured by Hartlaub. P_D is 13 to 14 mm. long and composed of 26 segments of which the first eight are rather thick and markedly broader than long. From the ninth segment onward the pinnule is more flagellate, and finally very slender with segments that are longer than broad. P_1, P_2, and P_3 are of similar structure but are stouter in the distal portion and not so flagellate. P_2 and P_3 decrease rapidly in length and in number of segments. P_4 is only 5 mm. long. The disk is 18 mm. in diameter.

The specimen from Dr. Merton's station 10 is small. The cirri are XXIII, up to 42, relatively very long, 19 to 23 mm. in length. The first two segments are broader than long, the third and fourth are about as long as broad, those following about as far as the twelfth are very markedly longer than broad, and from that point onward the segments are broader than long. The spines on the distal segments are sharp and prominent, and the cirri are strongly compressed laterally in the distal half. The 27 arms are only about 38 mm. long. All the division series following the IIBr series except for two are 2. P_D is 11 mm. long and is composed of 22 segments of which the proximal are relatively less broad than in the specimen from station 11. P_1 is about 12 mm. long and composed of about 28 segments. P_2 is markedly shorter, while P_3 is scarcely half as long as P_1 and is composed of about 12 segments. The disk is 10 mm. in diameter. The calyx and arms are dorsally light flesh color (in alcohol grayish white), the pinnules centrally being more or less violet; the cirri are dark violet.

Remarks.—Reichensperger said that because only two specimens of this fine species were previously known he had given a rather detailed account of some of the features of his two specimens with particular reference to the great difference in size between them. Of the smaller specimen he said that there is no possibility of doubt regarding the correctness of the specific determination because of the general habitus, the division series, the structure of the arms and other features. He noted that this individual shows very convincingly how little weight may at times be attributed to the relative length of the segments of the cirri and lower pinnules. He remarked that he was under the impression that in the crinoids increase in length often outstripped, as it were, increase in width, and that as a result during development the relative proportions of the segments, so far as regards length and breadth, reversed themselves as we not rarely find to be the case with other features. Naturally, therefore, in the crinoids the systematic worth of characters of this sort, which heretofore have often been very highly regarded, must be discounted, and they can only be taken into consideration in a relative way.

We know far too little about the growth changes in the comatulids, as apart from variations due to other causes, to be able to say anything definite one way or another at the present time. But Dr. Reichensperger has raised an interesting point and one worthy of intensive study.

The species of *Heterometra* are among the most puzzling of all the comatulids, and features that in other genera we believe may be confidently relied upon, such as the character of the cirri and the relative proportions of their segments and the relative proportions of the segments in the proximal pinnules, in some species of *Heterometra*, at least, are wholly unreliable. This is well illustrated by *H. crenulata*, which seems to behave quite as described by Dr. Reichensperger for *H. nematodon*, and furthermore seems to be most unstable in the same region—the Aru Islands.

Localities.—Bowen, Queensland [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1915, 1918; Reichensperger, 1913; H. L. Clark, 1921] (1, H. M.).

Alert; Port Molle, Queensland; 22–36 meters [Bell, 1883; A. H. Clark, 1913] (1, B. M.).

Aru Islands; Dr. H. Merton's station 10; north of Penambulai; 8 meters; stony bottom; April 2, 1908 [Reichensperger, 1913].

Aru Islands; Dr. H. Merton's station 11; off Pulu Bambu; 10 meters; rocky bottom, with sand and coral; April 3, 1908 [Reichensperger, 1913].

Geographical range.—Aru Islands and Queensland south to Port Molle.

Bathymetrical range.—From the shoreline down to 22 (?36) meters.

History.—The first known specimen of this species was a small individual collected by the *Alert*. At the time the *Alert* collections were studied it was not distinguished from the specimens of *Amphimetra discoidea* dredged at the same time and was recorded with these under the name of *Antedon milberti*.

Dr. Clemens Hartlaub in 1890 described this species as *Antedon nematodon* from a specimen from Bowen, Queensland, in the Hamburg Museum, redescribing and figuring it in the following year.

When the genus *Antedon* was first revised by me in 1907 *nematodon* was assigned to the new genus *Himerometra*.

In my memoir on the recent crinoids of Australia and also in my report on the crinoids collected by the Hamburg Southwest Australian Expedition, both of which were published in 1911, *nematodon* was transferred to the genus *Heterometra*. In both of these memoirs Port Molle was given as a locality for the species, and in the former this record was said to be based upon a small specimen which had been collected by the *Alert*. In my monograph on the crinoids of the Indian Ocean published in 1912, I gave *Heterometra nematodon* as occurring at Bowen and Port Molle and said that at the British Museum I had found, in a large jar full of specimens of *Amphimetra discoidea* (labeled *Antedon milberti*), a small example of this species dredged by the *Alert* at Port Molle in 12 to 20 fathoms.

In a paper on the crinoids of the Hamburg Museum published in 1912 notes were given on the type specimen, which the author had examined in 1910, and in 1913 in a paper on the crinoids in the British Museum the specimen from Port Molle was formally recorded. In both of these papers the species was assigned to the genus *Amphimetra* under the heading *Amphimetra nematodon*.

In 1913 Dr. August Reichensperger recorded, as *Heterometra nematodon*, two specimens collected by Dr. H. Merton in the Aru Islands in 1908. He gave extensive notes on these and also discussed certain peculiarities of the species as illustrated by them.

In the report on the unstalked crinoids of the *Siboga* expedition published in 1918, *nematodon* was included in the key to the species of *Heterometra* but was not further mentioned as it was not collected by the *Siboga*.

HETEROMETRA QUINDUPLICAVA (P. H. Carpenter)

PLATE 26, FIGURE 107; PLATE 34, FIGURES 149–151

[See also vol. 1, pt. 1, figs. 185, 186 (centrodorsal), p. 235; fig. 253 (centrodorsal), p. 253; fig. 470 (centrodorsal), p. 359.]

Antedon sp. P. H. CARPENTER, Quart. Journ. Geol. Soc., Feb. 1880, p. 41, footnote, pp. 42, 43 (*Challenger* station 212); *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, p. 51, 9th line.

Antedon clemens P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 229 (description; *Challenger* station 212), pl. 39, fig. 5.—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 37 (in key).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 273 (abnormal ray of type in its relation to arm structure of *Eudiocrinus*); vol. 39, 1911, p. 541 (same as *A. anceps* P. H. Carpenter and as *Craspedometra aliena* A. H. Clark [referring to specimens other than the type, which is *Heterometra crenulata*]); Crinoids of the Indian Ocean, 1912, p. 34 (identity); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76, footnote 1 (identity).

Antedon anceps P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 254 (description; *Challenger* station 212), pl. 35, figs. 1–3.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 17 (in key).—Koehler, Mém. Soc. Zool. France, vol. 8, 1895, p. 420 (Sunda Islands; Biliton; notes).—Minckert, Archiv für Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 212 (syzygies; regeneration).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, pp. 1579, 1582 (listed).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 541 (same as *A. clemens* P. H. Carpenter and as *Craspedometra aliena* A. H. Clark [referring to specimens other than the type, which is *Heterometra crenulata*]); Crinoids of the Indian Ocean, 1912, pp. 33, 35 (of P. H. Carpenter, 1888=*Craspedometra anceps*), p. 40 (of Chadwick, 1904=*Heterometra bengalensis*), p. 74 (B. M., MS.=*Capillaster multiradiata*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 80 (B. M., MS.=*Capillaster multiradiata*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76, footnote 1 (synonym of *quinduplicava*).

Antedon quinduplicava P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 262 (description; *Challenger* Station 212), pl. 4, figs. 1, *a-d*, pl. 47, figs. 4, 5.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 18 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 35 (identity).—Gislén, Arkiv för Zool., vol. 19, No. 32, 1928, p. 4, No. 17 (*Challenger* station 212; notes).

Himerometra anceps A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Smithsonian Misc. Coll., vol. 52, 1908, p. 214 (*Albatross* station 5147; also Philippine Islands).

Himerometra clemens A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 356 (listed).

Himerometra quinduplicava A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); vol. 52, 1908, p. 214 (*Albatross* station 5139; also Philippine Islands).

Amphimetra anceps A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 23 (published references to specimens in B. M.; *Challenger* station 212; notes).—Gislén, Arkiv för Zool., vol. 19, No. 32, February 20, 1928, p. 4, No. 17 (*Challenger* station 212; notes); Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 16.

Craspedometra aliena (part) A. H. Clark, Proc. U. S. Nat. Mus., vol. 37, 1909, p. 31 (*Albatross* station 5157; specimens other than the type, which is *Heterometra crenulata*).

Heterometra quinduplicava A. H. Clark, Proc. Biol Soc. Washington, vol. 22, 1909, p. 11 (listed); Vid. Medd. Nat. Foren. København, 1909, p. 162 (Singapore; description of a specimen), p. 163 (compared with *H. aspera*), p. 193 (collected at Singapore by Svend Gad); Crinoids of the Indian Ocean, 1912, p. 35 (identity), p. 130 (synonymy; range); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 27 (published reference to specimen in B. M.; *Challenger* station 212); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76 (in key; range), p. 81 (synonymy; notes; station 99), p. 272 (listed).—Gislén, Arkiv för Zool., vol. 19, No. 32, 1928, p. 4 (notes); A. H. Clark, Treubia, vol. 14, livr. 2, 1933, p. 212 (north of central Java; notes).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 27.

Craspedometra anceps A. H. Clark, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 541 (*Albatross* station 5355; *clemens* a synonym; *aliena* also a synonym [but not type specimen, which is *Heterometra crenulata*]); Crinoids of the Indian Ocean, 1912, pp. 33, 35 (=*anceps*), p. 34 (=*clemens*), p. 120 (synonymy; includes *aliena;* discussion of specimens upon which names have been based), p. 316 (Andaman Islands).—F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Pap. 90–D, 1914, pp. 34 ff. (inorganic constituents of the skeleton); Prof. Pap. 102, 1917, pp. 20 ff. (same); Prof. Pap. 124, 1922, p. 17 (same).

Diagnostic features.—The cirri have 25–36 (usually about 30) segments, which are subequal, usually about as long as broad; the outer are more or less carinate dorsally but never bear dorsal spines or tubercles. The enlarged proximal pinnules are slender and smooth, with the basal segments more or less abruptly rounded, sharpened, or obscurely carinate on the side toward the arm tip. The 10–26 (usually 15–20) arms, which are 60–145 mm. long, are composed of very short brachials.

Description.—The centrodorsal is discoidal, moderately thick, with the bare dorsal pole flat, 4 mm. in diameter. The cirrus sockets are arranged in one and a partial second irregular and closely crowded marginal rows.

The cirri are XXI, 32–36, 30 mm. long, moderately slender. The first segment is very short, and those following gradually increase in length to from the eighth to the thirteenth, which, with those following, is about as long as broad. The cirri decrease almost imperceptibly in width from the base outward and more rapidly on the last six or eight segments. On the terminal four to six segments the dorsal surface is slightly swollen so that the dorsal profile is slightly convex, the highest point in the convexity of the antepenultimate segment being beyond the middle. The middorsal line of the last five segments is more or less sharply carinate. The opposing spine is small, terminal, with the dorsal profile usually rising in a straight line from the proximal end of the segment; but occasionally the apex is slightly produced.

The radials are concealed by the centrodorsal except for their distal angles, which are visible interradially as low triangles with the produced apices reaching about halfway to the midradial line. The IBr_1 are very short, six to eight times as broad as long, slightly incised in the midradial portion of the distal edge. The IBr_2 (axillaries) are short, two to three times as broad as long, triangular with the lateral angles truncated, forming sides that are slightly shorter than the lateral borders of the IBr_1. The distal borders are nearly straight and the distal angle is somewhat greater than a right angle. The lateral borders of the elements of the division series are slightly produced and are in lateral contact. There are present eight IIBr 4 (3+4) series and eight IIIBr 2 series.

The 26 arms are 145 mm. long. The brachials beyond the proximal fourth of the arm are exceedingly short, four or five times as broad as long, and practically oblong.

P_1 is about 12 mm. long, with 25 segments. It tapers from the third to the tenth or eleventh segment and is very slender and delicate from that point onward. The basal segments are broader than long, the eighth segment is about as long as broad, and the outer are about half again as long as broad. The second-seventh segments have a prominent, though narrow, carinate process the crest of which is straight and parallel with the axis of the segment. This is highest on the fourth segment and slowly decreases in height distally. The outer surface of the earlier segments is swollen, this swelling gradually narrowing and in the outer half of the pinnule becoming a sharp gablelike ridge.

On arms arising from a IIIBr series P_1 is 15 mm. long, with 33 segments, and tapers much more gradually, thus more nearly resembling P_2. P_2 is about 20 mm. long, with 37 segments, tapering gradually and regularly to a delicate and flagellate tip. The basal segments are broader than long, the eighth is about as long as broad, and those following slowly increase in length so that the terminal are about twice as long as broad. The second-seventh segments have narrow carinate processes with a straight crest which are highest on the fourth and fifth; these give the pinnule the appearance of being broadest at this point and slowly tapering both toward the base and distally. A low crest runs along the outer surface of the pinnule which is at first broad and well rounded but becomes sharp after the eighth segment. P_3 is about 25 mm. long, with 35 or more segments, resembling P_2 and slightly, if at all, stouter basally but tapering more gradually so that it is considerably stouter in the outer portion. P_4 is 19 mm. long, with 26 segments, resembling P_2 but slightly less slender and with longer segments distally. P_5 is 13 mm. long, with 26 segments, and is less stout basally than the preceding pinnules.

The preceding description is based upon a magnificent specimen from the Danish Expedition to the Kei Islands station 72, which was originally described as a new species under the name of *Heterometra apollo* but which does not appear to differ in any essential feature from the specimens of *H. quinduplicava* previously known.

Notes.—The specimen from *Albatross* station 5355 is small with 18 arms about 80 mm. long and cirri from 20 to 22 mm. long.

Carpenter described *Antedon quinduplicava* from *Challenger* station 212 as follows: The centrodorsal is a thin disk with sloping sides. The cirri are about XVIII, 30. The segments are tolerably equal; the last few are rather compressed and faintly carinate, and the penultimate bears a slight opposing spine. The radials are just visible. The IBr_1 are rather closely united, forming a median prominence (synarthrial tubercle) with the pentagonal axillaries, and there is a similar but less marked prominence on the first two segments beyond the axillary. The IIBr series are 4(3+4), and the IIIBr series, when present, are 2. The 16 arms are about 80 mm. long. They are composed of 150 or more smooth brachials of which all but the terminal are broader than long. The lower brachials are subtriangular and the later ones are quadrate or almost oblong. Syzygies occur between brachials 3+4, again from between brachials 9+10 to between brachials 15+16, and distally at intervals of 5 to 11 (usually 8 or 9) muscular articulations. P_D is about equal to P_1. P_a is smaller again, while P_2 and P_b are both longer and stouter, reaching 11 mm., and are composed of about 18 smooth segments most of which are longer than broad, and the lower are carinate. The pinnules of the next pair are generally smaller again. But in arms arising from a IBr axillary P_3 and occasionally P_c may be large like those immediately preceding. The disk is 7 mm. in diameter, naked and much incised. Sacculi are abundant. The color in alcohol is brownish white with the perisome darker.

Carpenter said that he had some doubts as to the propriety of separating this form from *Antedon anceps*, which was found at the same station. The general characters of the cirri, calyx, and large lower pinnules are the same in both types. One individual of *Antedon anceps* has only 10 arms, but another has three and a third four IIBr series. The outer parts of the arms are rather serrate, and P_D is distinctly smaller than P_1. On the other hand, the two individuals he referred to *quinduplicava* each have IIIBr series, nearly smooth arms with longer intersyzygial intervals, and P_D of about the same size as P_1.

Carpenter remarked that, considering the remarkable series of variations in *Heterometra crenulata*, he thought it quite possible that we are here dealing with another case of the same kind, but in the absence of the necessary intermediate links he preferred to keep *quinduplicava* separate from *anceps* for the time being. He said that the only species which approaches *quinduplicava* and *anceps* at all closely is

H. savignii in which IIIBr series may or may not be present. But its more numerous and spiny cirri readily distinguish it from them both.

One of the two individuals included in *Antedon quinduplicava* by Carpenter was a mere fragment, which had lost its cirri, disk, and most of its arms. As it was practically useless in this condition, Carpenter made a preparation of its calyx (see beyond, page 250). I examined the type specimen of Carpenter's *Antedon quinduplicava* in the British Museum and found it to resemble those collected by the *Albatross* in the Philippines. The outer cirrus segments are slightly carinate dorsally.

Carpenter's description of *Antedon anceps* from *Challenger* station 212 is as follows: The centrodorsal is a low convex disk. The cirri are about XX, 25–35. The segments are tolerably uniform; a few of them are longer than broad, and the later are slightly carinate. The radials are partially visible. The IBr$_1$ are short and partly united, and there is a more or less distinct tubercle (a synarthrial tubercle) in the middle of their junction with the widely pentagonal IBr$_2$ (axillaries). The IIBr series, when present, are 4(3+4). The 10—14 arms are 85 mm. long. They consist of about 150 brachials of which the earlier are triangular and much broader than long, their successors becoming more quadrate and finally almost oblong with a slight tendency to overlap. Syzygies occur between brachials 3+4, from between brachials 9+10 to between brachials 13+14, and distally at intervals of from 3 to 10 (usually from 5 to 8) muscular articulations. The lowest pinnule, whether P$_D$ or P$_1$, is considerably smaller than its successor on the same side. In arms that spring direct from the IBr axillary the largest pinnules are P$_b$, P$_3$, and P$_c$, which may reach 12 mm. in length and consist of 20 smooth segments most of which are longer than broad, the later ones being carinate. On the inner arm borne by a IIBr axillary the largest pinnules are P$_2$ and P$_b$, though on the outer arms these are little, if at all, larger than P$_1$. But P$_a$ is always small. The disk is naked and much incised. Sacculi are very abundant on the disk, arms, and pinnules. The color in alcohol is white with patches or bands of a faded purple, and the perisome darker.

Gislén examined the type specimen of *anceps* in the British Museum in 1925. He said that it is a very curious individual. Two of the postradial series are either unbranched or forked after the IBr$_2$. He remarked that it is very interesting to notice that P$_1$ in both cases occurs to the left, just as in *Eudiocrinus*.

Antedon clemens from *Challenger* station 212 was described by Carpenter as follows: The centrodorsal is hemispherical. The cirri are about XXV, about 30. The segments are tolerably uniform and smooth, the penultimate with a small spine. The radials are not visible. The IBr$_1$ are slightly united laterally and the IBr$_2$ (axillaries) are pentagonal. In the single specimen included by Carpenter under this name one postradial series does not divide at all, three possess IBr series, and one has a IIBr 2 series. The 11 arms are about 75 mm. long. The arms are smooth, composed of triangular brachials, which are much broader than long, the brachials later becoming quadrate. Syzygies occur between brachials 3+4, again from between brachials 9+10 to between brachials 13+14, and distally at intervals of 2–10 (usually 5–7) muscular articulations.

The first pinnule is 5 mm. long with about 20 segments, which diminish greatly in size after the first five or six. The next pair (P$_2$ and P$_b$) are much longer with a smaller number of stouter segments, several of which are considerably longer than broad. The third pair (P_3 and P_c) are smaller again. The more distal pinnules of each pair (that is, those on the inner side of the arm) are smaller than the more proximal ones (on the outer side of the arm). The pinnules of the eighth and following brachials have slight dorsal keels on their lower segments. The disk is 7 mm. in diameter, naked and rather incised. Sacculi are abundant on the pinnules.

Carpenter said that on the undivided postradial series there is a pinnule on the second ossicle, but none on the next. It is clear therefore that a IBr series is present, but the IBr_2 is not axillary, as in the arms of the species of *Eudiocrinus* (see page 143). One postradial series does not divide until the fourth ossicle beyond the radial, the axillary being a "syzygial joint," and the second and third segments bear pinnules. One of the IBr series is thus 5(4+5). In Carpenter's description the division of the postradial series as described would give 10 arms, but the number of arms is said to be 11. The mention in the discussion of the species of this aberrant IBr series corrects this discrepancy.

I examined the type specimen of *Antedon clemens* in the British Museum in 1910 and found that it most certainly represents the same species as the type specimen of *A. anceps*.

The specimen from *Siboga* station 99 has 26 arms 80 mm. long. Two of the arms arise directly from IBr axillaries. There are eight IIBr 4(3+4) series each of which bears internally a IIIBr 2 series. The cirri are XVIII, 27–30, 22 mm. long. This example exactly resembles one from *Albatross* station 5139.

The specimen from north of central Java is small. It has 16 arms and is undergoing adolescent autotomy.

Of the two specimens recorded by Professor Koehler from Biliton, which were in very bad condition, one has 12 and the other 13 arms.

The specimen from the Danish Expedition to the Kei Islands station 103 is smaller than that upon which the description of the species as given above is based (from station 72); it has 23 arms 110 mm. long. Of the nine IIBr series present, eight are 2 and one is 4(3+4). Three IIIBr series are present, of which two, both on the same IIBr series, are of a single ossicle only, and one is 2. There is a single IVBr 2 series, developed internally on a IIIBr 1 series. The cirri are XX, 29–31, from 20 to 25 mm. long.

The two specimens from Singapore have the arms about 60 mm. long. One has 21 arms, resulting from the presence of six IIBr 4(3+4) series and five IIIBr 2 series, the latter all developed internally in 1, 2, 2, 1 order. The other specimen is similar. These specimens agree in every way with others at hand from the Philippine Islands. P_D, though larger than usual in this genus, is nevertheless smaller than P_1.

The specimen from the Andaman Islands is immature with 14 arms about 100 mm. long.

Radials.—Carpenter found, by dissecting one of the two specimens that he referred to *Antedon quinduplicava*, that each of the radial areas on the ventral surface of the centrodorsal is marked at its proximal end by a large bilobate pit, so that every two pits are separated by an interradial ridge. These pits seem to be nothing but an unusual development of the radial pits that occur around the lip of the centrodorsal in so many comatulids and receive the lower ends of the axial radial canals, and so in fact they are. But their capacity is increased by the presence of corresponding pits on the under surface of the radial pentagon into which the axial canals, contained between the inner faces of the radials and the spouts of the rosette, open directly. Carpenter said that the only comatulid in which he had found any large cavity of a similar kind within the calyx is *Comatula solaris*. In *Comatula solaris* the radial axial canal, though it terminates blindly at the top of the centrodorsal, communicates with a large cavity in the lowest part of the radial, while in *H. quinduplicava* this cavity is outside and below the radial, between it and the centrodorsal.

Localities.—*Albatross* station 5355; North Balabac Strait; Balabac Light bearing S. 61° W., 16.6 miles distant (lat. 8°08′10″ N., long. 117°19′15″ E.); 80 meters; coral and sand; January 5, 1909 [A. H. Clark, 1911, 1912, 1918] (1, U. S. N. M., 35104).

Challenger station 212; Philippine Islands, off Zamboanga (lat. 6°54′ N., long. 122°18′ E.); 18 meters; sand; January 30, 1875 [P. H. Carpenter, 1880, 1884, 1888; Hartlaub, 1891; A. H. Clark, 1907, 1908, 1909, 1911, 1912, 1918; Reichensperger, 1913] (5, B. M.).

Siboga station 99; anchorage off North Ubian (lat. 6°07′30″ N., long. 120°26′00″ E.); 16–23 meters; lithothamnion bottom; June 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Albatross station 5139; in the vicinity of Jolo (Sulu); Jolo Light bearing S. 51° W., 3.6 miles distant (lat. 6°06′00″ N., long. 121°02′30″ E.); 36 meters; coral sand; February 14, 1908 [A. H. Clark, 1908, 1912, 1918] (1, U. S. N. M., 35183).

Albatross station 5147; Jolo (Sulu) archipelago; in the vicinity of Siasi; Sulade Island (E.) bearing N. 3° E., 8.4 miles distant (lat. 5°41′40″ N., long. 120°47′10″ E.); 38 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1908, 1912, 1918].

Albatross; Philippine Islands; 1907–'08 [A. H. Clark, 1908] (3, U.S.N.M., 35206).

North of central Java (lat. 5°41′ S., long. 109°21′ E.); November 21, 1907 [A. H. Clark, 1933] (1, Buitenzorg Mus.).

Biliton; M. Korotnev, 1885 [Koehler, 1895; A. H. Clark, 1912].

Danish Expedition to the Kei Islands station 72; Dr. Th. Mortensen; Java Sea (lat. 5°41′ S., long. 105°57′ E.); 35 meters; stones and sponges; July 28, 1922 (1, the type specimen of *H. apollo;* C.M.).

Danish Expedition to the Kei Islands station 103; Dr. Th. Mortensen; Sunda Straits (lat. 6°05′ S., long. 105°42′ E.); 52 meters; shell bottom; August 4, 1922 (1).

Singapore; Svend Gad [A. H. Clark, 1909, 1918] (2, C.M.)

Investigator; Andaman Islands [A. H. Clark, 1912] (1, I.M.).

Geographical range.—From the Philippines to Biliton, Java, Singapore, and the Andaman Islands.

Bathymetrical range.—From the shoreline down to 80 meters. The average of eight records is 33 meters.

History.—This species was first mentioned by Dr. P. H. Carpenter simply as "*Antedon*" in an article on fossil comatulids published in 1880. He said that in one of the *Challenger* Antedons only four rays divide out of the five, the fifth remaining simple and undivided as is the case with all the rays of *Ophiocrinus* (=*Eudiocrinus*). This refers to the specimen that he later (1888) described under the name of *Antedon clemens*. In the same paper he said that in a *Challenger* species of *Antedon* from station 212 the ridges bordering the interarticular ligament fossae above run almost vertically upward for some little distance and then curve outward, so that the size of the muscular fossae above them is greatly reduced. Farther on he said that the only *Antedon* he knew that in the relation of the interarticular ligament and the muscular fossae presents features at all resembling those of *Actinometra* (that is, the Comasteridae) is the anomalous *Challenger* species from station 212. In this the arrangement of the ridges is essentially the same as it is in *Actinometra*, though the shape of the distal faces of the radials is somewhat different. The specimen which he dissected was the fragment identified (in 1888) as *Antedon quinduplicava* which had lost its cirri, disk, and most of its arms. As it was practically useless in this condition, he made a preparation of its calyx.

In the *Challenger* report on the stalked crinoids published in 1884 Carpenter mentioned an *Antedon* in which one of the rays consists of five joints, the axillary being a syzygy. This was the specimen he later (1888) described under the name of *Antedon clemens*.

In the *Challenger* report on the comatulids published in 1888 Carpenter described *Antedon clemens* in the *Palmata* group and *Antedon anceps* and *A. quinduplicava* in the *Savignyi* group. *Antedon anceps* he also placed in his key to the species of the *Milberti* group and he noted it among the species of that group collected by the *Challenger* for the reason that one of the specimens had only 10 arms. He said that the single specimen of *Antedon clemens* is unique in every way, but he had some doubts as to the propriety of separating *A. quinduplicava* from *A. anceps*. The three specimens identified as *Antedon anceps*, the single specimen and fragment of another determined as *A. quinduplicava*, and the single specimen described as *A. clemens* all came from *Challenger* station 212.

Dr. Clemens Hartlaub in 1891, following Carpenter, included *clemens* in his key to the species of the *Palmata* group, and *anceps* and *quinduplicava* in his key to the species of the *Savignyi* group.

Prof. René Koehler in 1895 recorded and gave notes upon two specimens identified as *Antedon anceps* from Biliton.

In my revision of the old genus *Antedon* published in 1907, *anceps*, *clemens*, and *quinduplicava* were referred to the new genus *Himerometra*.

In 1908 I recorded *Himerometra quinduplicava* from *Albatross* station 5139, and also from the *Albatross* Philippine collection with no definite locality, and *Himerometra anceps* from *Albatross* station 5147 and from the Philippines with no definite locality.

In my revision of the family Himerometridae published in 1909, I referred *anceps* to my new genus *Amphimetra*, while *quinduplicava* was assigned to the new genus *Heterometra; clemens* was not mentioned.

In a paper on the crinoids in the Zoological Museum at Copenhagen published in 1909, I recorded and gave notes upon two specimens of *Heterometra quinduplicava* from Singapore.

In a paper including descriptions of five new comatulids published on August 23, 1909, I established the new species *Craspedometra aliena*. The type specimen of this supposed new form was an example of *Heterometra crenulata*, but other examples included under this name in reality represented *quinduplicava*.

In a third paper on the crinoids collected by the *Albatross* in the Philippines, which was published in 1911, I recorded a small specimen of *Craspedometra anceps* from station 5355 and added a note to the effect that an examination of the *Challenger* types in London had shown that Carpenter's *Antedon clemens* is the same thing as his *Antedon anceps* and as my *Craspedometra aliena*.

In my memoir on the crinoids of the Indian Ocean published in 1912, I included *Craspedometra anceps*, with *Antedon clemens* and *Craspedometra aliena* as synonyms. I said that an examination of the *Challenger* material in London had shown me that my *Craspedometra aliena* is merely a very large form of the species that Carpenter called *anceps* and, furthermore, that Carpenter's *clemens* is also the same thing as his *anceps*. I remarked that the earlier pinnules of this species sometimes have the curious production of the distal corners of the segments which Carpenter described in *Amphimetra variipinna* (=*Heterometra crenulata*) and in *Oligometra serripinna*. This statement was the result of the confusion arising from the inclusion of specimens of both *Heterometra crenulata* and *H. quinduplicava* under *Craspedometra aliena*. Farther on I gave *Heterometra quinduplicava*, with its synonymy and range. In an appendix I recorded a specimen of *Craspedometra anceps* from the Andaman Islands.

In a paper on the comatulids in the British Museum published in 1913, I included *Amphimetra anceps*, with *Antedon clemens* as a synonym, and also *Heterometra quinduplicava*.

In my memoir on the unstalked crinoids collected by the *Siboga*, published in 1918, I placed *Antedon clemens* and *A. anceps* in the synonymy of *Heterometra quinduplicava*, of which I recorded a specimen from station 99. On the basis of the type specimen *Craspedometra aliena* was placed in the synonymy of *Heterometra crenulata*.

In 1933 I recorded a specimen in the Buitenzorg Museum from north of central Java.

HETEROMETRA CRENULATA (P. H. Carpenter)

PLATE 23, FIGURES 89–92; PLATE 24, FIGURES 93–96; PLATE 25, FIGURE 101; PLATE 26, FIGURES 102, 103

[See also vol. 1, pt. 2, figs. 445, 446 (pinnule tip), p. 261; fig. 718 (disk), p. 346.]

?*Comatula dubia* VON GRAFF, Das Genus *Myzostoma*, 1877, pp. 15, 22, 72, 79 (Semper, MS.; near Bohol, Philippines; myzostomes; *nomen nudum*).—BRAUN, Centralbl. für Bakteriol. und Parasitenk., vol. 3, 1888, p. 185 (myzostomes; after von Graff).—A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 77, footnote [6] (identity).

Antedon crenulata P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 507 (description; neighborhood of Borneo; discussion); Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula).—A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity).—GISLÉN, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 25.

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Antedon irregularis BELL, Proc. Zool. Soc. London, 1882, p. 534 (specific formula).—P. H. CARPENTER, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula).—BELL, Report Zool. Coll. H. M. S. *Alert*, 1884, p. 155 (specific

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formula), p. 161 (description; Prince of Wales Channel; Torres Strait), pl. 13, figs. A, *a–c*.—P. H. Carpenter, Quart. Journ. Micr. Sci., vol. 27, 1887, p. 386 (sacculi fairly abundant on pinnules).—A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 714 (identity); Crinoids of the Indian Ocean, 1912, p. 31 (identity); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 83 (identity).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 25.—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 6 (identity).

Antedon dubia von Graff, *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, pp. 15, 18, 47 (Bohol, Philippines; myzostomes; *nomen nudum*).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 110, 197, 258–261 (Arrou Islands), pl. 36, figs. 1–6.—Minckert, Archiv für Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 212 (syzygies; regeneration).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 25.

Antedon bidentata von Graff, *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, pp. 15, 16, 17, 49, 57, 59 (*Challenger* station 186; myzostomes); Narrative, vol. 1, pt. 1, 1885, p. 316 (same); Zoology, vol. 20, pt. 61, 1887, p. 7 (same).—P. H. Carpenter, Quart. Journ. Micr. Sci., vol. 27, 1887, p. 386 (sacculi scanty on pinnules); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 97 (*Challenger* station 187; naked disk), p. 262 (identity).—Braun, Centralbl. für Bakteriol. und Parasitenk., vol. 3, 1888, p. 186 (myzostomes; after von Graff).

Antedon variipinna P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 198 (Arrou Islands; notes), p. 256 (synonymy; description; *Challenger* station 186; Arrou Islands; other records; discussion), pl. 36, figs. 1–6, pl. 48, figs. 3–5, pl. 49, figs. 1, 2.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 17 (in key).—Bell, Proc. Zool. Soc. London, 1894, p. 394 (northwest Australia, 9–38 fathoms).—Koehler, Mém. Soc. Zool. France, vol. 8, 1895, p. 419 (Sunda Is.; Biliton; notes).—D'Arcy Thompson, Proc. Roy. Soc. Edinburgh, vol. 22, 1900, p. 322 (range).—Bell, *in* Gardiner, Fauna and geography of the Maldive and Laccadive Archipelagoes, vol. 1, pt. 3, 1902, p. 224 (South Nilandu, 19 fathoms).—Minckert, Archiv für Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 212 (syzygies; regeneration).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, pp. 1580, 1582 (listed).—A. H. Clark, Mem. Australian Mus., vol. 4, 1911, pp. 716, 719 (identity of records by P. H. Carpenter, 1888, and Bell, 1894); Crinoids of the Indian Ocean, 1912, pp. 34, 35, 38, 40 (identity of previous records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 88 (identity of specimens in B. M.).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 5 (identity).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 25.

Himerometra variipinna A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed; in part); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 225 (comparison with *H. producta*); Smithsonian Misc. Coll., vol. 52, 1908, p. 216 (*Albatross* Station 5157).

Amphimetra variipinna A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Proc. U. S. Nat. Mus., vol. 37, 1909, p. 32 (proximal pinnules compared with those of *Craspedometra aliena*); Vid. Medd. Nat. Foren. København, 1909, p. 156 (Singapore; description of specimens), p. 157 (compared with *A. producta*), p. 193 (collected at Singapore by Svend Gad); Proc. U. S. Nat. Mus., vol. 39, 1911, p. 540 (*Albatross* stations 5358, 5481); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 436 (*Alert* records; northwest Australia), p. 440 (East Indian species occurring south to Baudin Island and Port Curtis), p. 443 (range on east coast), p. 444 (range on west coast), p. 446 (summary of west Australian records); Mem. Australian Mus., vol. 4, 1911, p. 722 (occurs south to Port Curtis), p. 723 (northwest Australia; Baudin Island), p. 734 (in key), p. 764 (synonymy; characters; localities; notes; range), p. 765, footnote (Chadwick's record from Ceylon is *Heterometra reynaudi*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 16 (*Antedon variipinna* of Carpenter not this species); Crinoids of the Indian Ocean, 1912, p. 31 (includes *decipiens* and *irregularis* Bell, 1884), pp. 34, 35 (=*variipinna* P. H. Carpenter, 1888), p. 36 (=*variipinna* Bell, 1894), p. 110 (synonymy; Pocock Island, 20 fathoms; description and comparisons; summary of previous records); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 314 (correction of identity).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 3 (listed), p. 5 (stations 7, 11), p. 23 (detailed descriptions), p. 26.

Craspedometra aliena A. H. Clark, Proc. U. S. Nat. Mus., vol. 37, 1909, p. 31 (*Albatross* station 5157; description); vol. 39, 1911, p. 541 (considered a synonym of *anceps* [*quinduplicava*]).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 100 (comparisons).—

A. H. Clark, Unstalked crinoids of the *Siboga* Exped., 1918, p. 77, footnote 1 (synonym of *crenulata*).

Amphimetra crenulata A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, pp. 2, 16 (identity); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 314 (correction of previous records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 22 (published references to specimens in B. M.; localities; notes); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, pp. 223 ff. (detailed account of distribution in Australia).—H. L. Clark, Biol. Results Fishing Exper. F. I. S. *Endeavour*, 1909–14, vol. 4, pt. 1, 1916, p. 21 (new locality; notes).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 3 (discussion); Zool. Bidrag Uppsala, vol. 9, 1924, p. 39, footnote (disk reaches to $IIBr_4$), p. 44 (reversion), p. 47 (obliquity of joint faces), pp. 77, 78 (syzygies), p. 285 (Cape Jaubert, 21 m.; details), fig. 33, p. 52, fig. 69, p. 75.

Antedon philiberti Brit. Mus., MS. A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 110; Smithsonian Misc. Coll. vol. 61, No. 15, 1913, p. 22 (northeastern Australia; J. B. Jukes).

Actinometra solaris Brit. Mus., MS. A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 22 (Prince of Wales Channel; 5–7 fathoms).

Craspedometra aruensis Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 82 (Aru Islands), p. 99 (west of Ngaiguli, 14 meters; detailed description and comparisons), fig. 8, p. 100 (lower pinnules).

Craspedometra anceps Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 82 (Aru Islands), p. 99 (details of the locality; notes; comparisons), fig. 8, p. 100 (lower pinnules).

Heterometra crenulata A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 77 (in key; range), p. 79 (synonymy; notes; stations 273, 274), p. 275 (listed).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, pp. 5, 6 (history), pp. 21, 192 ff. (distribution).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 215 (disk).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 638 (Baudin Island; 8–15 fathoms); Treubia, vol. 14, livr. 2, 1933, p. 212 (localities; notes).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 27; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (French Indochina), p. 6 (range), p. 9 (localities; notes).—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 33 (Roebuck Bay, 5–8 fathoms; Broome; Norwest Islet, Capricorn group; notes).

Heterometra variipinna Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 7, 16, 27.

Diagnostic features.—This very variable species is easily recognized by the enlarged lower pinnules, which are very strongly prismatic, the outer portion of the prismatic ridges on each segment being raised into conspicuous broad rounded triangular processes so that the profiles of the pinnules are very strongly serrate, the teeth of the serration having broadly rounded ends.

The animal is usually (though not always) stout and robust, with the dorsal surface of the elements of the division series and of the brachials swollen and with well-developed broadly rounded synarthrial and articular tubercles. The enlarged lower pinnules are usually (but not always) much stiffened and sometimes spinelike.

Notes.—The specimen from *Albatross* station 5481 is small with 12 arms.

The specimen from *Albatross* station 5358 has 11 arms 150 mm. long. The cirri are XI, 34–41, from 35 to 37 mm. long, rather more slender than usual. The processes on the segments of the proximal pinnules are less developed than is usually the case, and the general appearance of the animal is less rugged than in typical examples. The individual probably is not quite mature.

The two specimens from *Albatross* station 5157 upon which *Craspedometra aliena* was based proved to be unusually slender and poorly developed examples of *crenulata*. The centrodorsal is thick discoidal with the bare polar area flat, 2–4 mm. in diameter. The cirrus sockets are arranged in a single or partially double alternating marginal row.

The cirri are XV–XVII, 29–36 (usually 35 or 36), 30 mm. long. They are moderately stout basally but taper very gradually to a slender tip. The first segment is short and those following gradually increase in length to the fourth or fifth, which is about as long as broad, the remainder being slightly longer than broad. The terminal 10 to 14 segments may have a slight dorsal carination. The opposing spine is small but prominent, terminal or subterminal, and is equal to one-third the width of the penultimate segment in height. The terminal claw is somewhat longer than the penultimate segment and is slender and slightly curved. The segments in the distal half or two-thirds of the cirri have purple saddle-shaped markings. The radials may be entirely concealed in the midradial line, or they may be equal to half the length of the IBr_1. The IBr_1 are oblong, short, five or six times as broad as long, and laterally in contact. The IBr_2 (axillaries) are short, almost or quite triangular, two and one-half to three times as broad as long. The IIBr series are 4(3+4)—in one of the specimens two of them are 2—and are in close lateral apposition and flattened against their neighbors. One of the two specimens possesses a single IIIBr 2 series, which is developed internally.

The 15–20 arms are 140 mm. long, and are elongated, slender, and evenly tapering. The first two brachials are subequal in size, slightly wedge-shaped, three to four times as broad as long in the middorsal line. The first syzygial pair (composed of brachials 3+4) is oblong, two and one-half or three times as broad as long. The next five brachials are approximately oblong, nearly four times as broad as long in the median line. The following brachials are triangular, somewhat over twice as broad as long with the longer side somewhat convex, after the proximal fourth of the arm becoming wedge-shaped, about three times as broad as long, and slightly longer terminally. Syzygies occur between brachials 3+4, again from between brachials 14+15 to between brachials 29+30, and distally at intervals of 11 to 19 muscular articulations.

P_D is small and weak, about 6 mm. long, and composed of 13–16 segments, all of which are about as long as broad. P_1 is similar but slightly larger, 7 or 8 mm. long. P_2 is 9 to 12 mm. long with 18 segments, much stouter and stiffer than the preceding pinnules, and ending abruptly with a stiffened tip more or less as in the species of *Stephanometra*. The first two segments are not so long as broad, the third is about as long as broad, and the remainder are longer than broad, becoming twice as long as broad distally. The pinnule may be slightly carinate basally, and after the second or third the distal dorsal ends of the segments become thickened and project strongly, forming lateral processes resembling those in the type of *crenulata*. P_3 is slightly stouter and slightly longer than P_2, but similar to it though usually with a few less segments. P_4 is 9 mm. long, comparatively slender, and its segments do not bear lateral processes; the segments become about as long as broad on the fourth or fifth and about twice as long as broad terminally. The following pinnules are similar, gradually increasing to 10 mm. in length, and then becoming more slender and slowly decreasing to 8 mm. in length. The color in alcohol is white, the segments in the distal half or two-thirds of the cirri with purple saddle-shaped markings.

The type specimen of *Antedon crenulata* was thus described by Carpenter: The centrodorsal is a thick convex disk 5 mm. in diameter with a single or partially double row of cirri. The cirri are about XX, 30+. The sixth segment is longer than broad and those following are tolerably equal. The eleventh segment and its successors bear strong forward projecting dorsal spines which diminish again after about the twenty-fifth segment. The radials are partially visible, and have crenulated distal edges. The IBr$_1$ are trapezoidal, closely united laterally, and rising rather sharply toward the middle of their junction with the pentagonal axillaries, which are about twice their length. The postradial series are very close together, and divide twice, or sometimes three times. The IIBr series are 4(3+4) and the IIIBr series are 2. The first 2 segments beyond each axillary form a slight tubercular elevation (synarthrial tubercle) at the middle line of their junction. The first brachials are rhomboidal and are closely united laterally. The second brachials are longer and are sharply wedge-shaped. The first syzygial pair (composed of brachials 3+4) and the five or six following brachials are short and oblong, and those succeeding are triangular, more than twice as broad as long, and overlapping, gradually becoming smoother and more oblong in the middle and outer parts of the arms. Syzygies occur between brachials 3+4, again from between brachials 13+14 to between brachials 14+15, and distally at intervals of 8–11 muscular articulations.

The pinnules are variable. P_D seems to have been less stout than P_1 P_a is small, usually less than half the length of P_b. On the outer arms of the postradial series the fifth, sixth, and seventh brachials bear large pinnules (P_2, P_b, and P_3) like that on the second (P_1). Sometimes P_2 and sometimes P_3 is the largest. The pinnules of the next pair, on the eighth and ninth segments (P_4 and P_d), are smaller again. On the inner arms the fifth brachial bears a small pinnule (P_2) like that on the fourth (P_a), and the next two pairs are large, the second pair, on the eighth and ninth brachials (P_c and P_4) being the larger. Sometimes, however, the only two really large pinnules are those of the seventh and eighth brachials (P_3 and P_c), the preceding pair being smaller, but not especially so, like P_a. These long lower pinnules consist of about 25 stout segments the distal ends of which have forward-projecting lateral processes. In the large lower segments these are chiefly limited to the outer side, but they appear on both sides in the later segments. Similar but less marked processes are visible on the cylindrical segments of the remaining pinnules, which increase again in size after the fifth pair but never become so long as the large lower pinnules. The color of the skeleton seems to have been white and that of the perisome purplish.

Carpenter said that the preceding description was based upon some dried fragments of a moderately large *Antedon*, which appeared to be new. He said that it is altogether a larger species than *variipinna*, from which it is readily distinguished by its crenulated radials, tubercular arm bases, and smoother arms, while the inequality in the sizes of the lower pinnules is not of the same character in the two species.

In the specimen from Tonkin the cirri have 44–48 segments, the outer with dorsal knobs. The IIBr series are 4 (3+4). Of the eight IIIBr series, four are 2 and four are 4 (3+4). The single IVBr series is 3. One of the IBr series is 6 (5+6), with a pinnule on the fourth element. There are 27+ arms. P_3 is the longest pinnule, 30 mm. long with 33 segments. The distal segments have the distal portion everted and spinous, and a little angular. There are faint tubercles at the distal outer borders.

The Annam specimen has 32–36 cirrus segments, each with a dorsal longitudinal keel tending to form an indistinct dorsal tubercle. The IIBr series are 4 (3+4). Of the three IIIBr series, two are 2 and one is 4 (3+4). The radials are visible;

they are crenulated. There are 20 arms. The arm bases are less rugged than those of the preceding specimen. P_3 is about 20 mm. long with 22 segments; the eversion and spinosity of the distal segments is not very prominent. The individual is young.

In the specimen from Cambodia the cirri have been lost. The IIBr series are 4 (3+4). Of the five IIIBr series present, three are 2 and two are 4 (3+4). P_3 is about 30 mm. long with 27 segments. The everted ends of the segments and the tubercles are well developed.

The four specimens from north of central Java are all small.

One of the specimens from north of western Java has 10 and the other has 11 arms. The lateral processes on the segments of the proximal pinnules are strongly developed but slender.

One of the specimens from off Cape Jabung, Sumatra, has 22 arms. Of the ten IIBr series present, nine are 4 (3+4) and one is 2. There is one IIIBr 4 (3+4) series following a IIBr 2 series, and one IIIBr 2 series following a IIBr 4 (3+4) series. Both of the IIIBr series are internally developed.

One of the specimens collected by Svend Gad at Singapore has 19 arms 80 mm. long. The cirri are XV, 31–34, 20 mm. long. P_2 is 13 mm. long, with 20–23 segments. Six IIBr series are present on four postradial series of which five are 4 (3+4) and one is 2. There is one IIIBr 2 series, developed internally. In alcohol this specimen is flesh colored, with the arms crossed by purple bands.

Another specimen from Singapore has 12 arms 80 mm. long and the cirri XIX, 32–35, 23 mm. long. There are two IIBr series developed on adjacent postradial series. The color in alcohol is dark brown.

A third specimen from Singapore has 15 arms 80 mm. long. There is a single IIBr series on each postradial series. Of the five IIBr series four are 4 (3+4) and one is 2. The cirri are XVIII, 28–30, 20 mm. long.

A fourth example resembles that immediately preceding and is of exactly the same size with 16 arms. All the IIBr series are 4 (3+4). The cirri are XVIII, 30–35. Both of these specimens are flesh colored.

A specimen from Singapore collected by Mr. Gad and dated October 23, 1910, has 14 arms 62 mm. long. One of the IIBr series is 2. One postradial series bears two IIBr series, both 4 (3+4).

Another specimen with the same date has 14 arms 75 mm. long. The cirri are XIX, 31, 20 mm. long. The dorsal pole of the centrodorsal is convex, 2.5 mm. in diameter.

Prof. F. Jeffrey Bell's *Antedon decipiens* was based upon specimens from the Arafura Sea in 32–36 fathoms, Dundas Strait, and the Prince of Wales Channel. He provisionally associated with it, as a variety, two specimens from *Alert* station 144 (probably Thursday Island). The characters he gave for *Antedon decipiens* are the following:

The centrodorsal is small, with the cirri arranged on three levels. The cirri are about XX, 25, about 16 mm. long. The fourth-tenth segments are longer than broad and those following, which gradually become shorter, are provided with a well-marked spine. These spines decrease toward the end of the cirri, but the penultimate one is larger again. The radials are quite distinct. The IBr_1 are oblong, three times as long as broad (he meant as broad as long), partly in contact. The IBr_2 (axillaries) are almost triangular. The arms may or may not divide. Where the arms divide the IIBr series are 4(3+4). The arms are about 14–18 in number and about 70 mm. long. The first brachials, or the first elements in the IIBr series, are always broad, and touch. The first brachials, which have sharp overlapping distal edges, are pretty regularly oblong; at about the seventh they become alternatingly wider on either side, to again become more regular later on. The first brachial syzygy is between brachials 3+4, the second is from between brachials 13+14 to between brachials 16+17, the third is from between brachials 24+25 to between brachials 27+28, and those following are separated by from 11 to 13 muscular articulations. P_D (when present) and P_a short. P_b to P_d are much longer with the basal segments very stout, the free ends very delicate, and their outer side produced into a well-marked conical process. The succeeding pinnules are shorter, and these again increase in length; they are not composed of a large number of segments. The disk is small.

Bell said that in the two varietal specimens from *Alert* station 144 the cirri are rather more numerous and more jointed, the whole animal appears to be more slender and delicate, and the color is ashy gray.

Bell's *Antedon irregularis* was based upon specimens from the Prince of Wales Channel and from Torres Strait. He described it as follows: The centrodorsal is flattened and small; the cirri are arranged in two marginal rows. The cirri are about XXV (but there may be not more than XV), 30–35, the longest 24 mm. long. The basal segments are short, the fourth-ninth are longer than broad, the segments then shortening again. There are no dorsal spines, except on the penultimate segment, and that is exceedingly small. The radials are not at all, or are barely, visible. The IBr_1 are broad, in contact, with a median convex protuberance (a synarthrial tubercle). The IBr_2 (axillaries) are almost perfectly triangular. The IIBr series are 4(3+4), and the IIIBr series, when present, are 2. The 11–22 arms are about 85 mm. long. The earlier brachials have a well-rounded convex dorsal surface and are broader than long; soon, however, they become very markedly wedge-shaped and form a prominent projection alternating on either side (the articular tubercles). Toward the end of the arms these disappear. Syzygies occur between brachials 3+4, 11+12, and 21+22; or 3+4, 12+13, and 23+24; or 3+4, 14+15, and 23+24; or 3+4, 15+16, and 23+24; the distal intersyzygial interval is 7 to 11 muscular articulations. The first pinnules are very short; the third and fourth are the stoutest and longest, quite stiff, with well-developed broad lower segments, each of which has a marked protuberance on each side. The succeeding pinnules are shorter, and then again longer. The diameter of the disk is 6 mm. The color is pale flesh color, occasionally with a dark band here and there, especially at the syzygies. Sometimes there is a good deal of brown. The cirri are typically banded purple and white.

Bell said that *Antedon irregularis* has some resemblance to *A. decipiens*, but it may be distinguished from the latter by the absence of spines from the segments of the cirri, the broader lower pinnules, and the greater length of the more distal pinnules.

The specimens secured by the *Challenger* at station 186 and at the Aru Islands were thus described by Carpenter: The centrodorsal is a low and slightly convex disk. The cirri are XV–XXX, 20–35. Some of the lower segments are longer than broad; the later are usually somewhat compressed laterally and rather sharply carinate in consequence, but they sometimes bear well-marked spines. The radials are never altogether invisible in lateral view and are often comparatively large and granulated externally. The IBr$_1$ are short, broad, and laterally united, forming more or less of a prominence at the middle of their junction with the broadly pentagonal IBr$_2$ (axillaries). The postradial series divide twice and sometimes three times. The IIBr series are 4(3+4) and the IIIBr series, when present, are 2. The dorsal surface of the elements of the division series is often considerably arched. The arms vary in number from 11 (probably even 10) to 25 or more; they are 100 mm. long and may have 180 brachials. The first six or eight brachials are relatively short and broad, nearly oblong in outline, and often much rounded dorsally. The following brachials are more triangular, with a variable tendency to overlap dorsally, and their broader ends project alternately on opposite sides of the arm to a greater or less extent. Farther out they become more quadrate again, but remain relatively short and broad and more or less overlapping until almost the very end of the arm. The first brachial syzygy occurs between brachials 3+4, and the second from between brachials 11+12 to between brachials 16+17; the distal intersyzygial interval is 7–13 (usually 10 or 11) muscular articulations

The first pinnules are comparatively small and consist of about 20 short segments of which the lowest are broad and slightly carinate. P$_D$, if present, is smaller than P$_1$, and so is P$_a$. The following pinnules may reach nearly 15 mm. in length, with as many as 25 segments, which are both longer and stouter than in the lower pinnules. The relative sizes of the pinnules vary greatly. In the outer arm from each IIBr series the largest pinnules are generally P$_2$ and P$_b$, but on the inner arm the largest pinnules are P$_b$ and P$_3$ (on the seventh and eighth brachials), while on arms borne directly on the IBr axillaries P$_3$ and P$_c$ are usually the longest. All but the lowest of these large pinnules have strong and blunt lateral processes at their distal ends. The pinnules of the next pair are generally considerably smaller, with relatively shorter segments, which gradually become more elongated in the slender distal pinnules but lose the lateral processes at their ends. The disk is 10 mm. in diameter naked, and much incised. The sacculi are small but abundant. The color in alcohol is ashy gray, white, or pale flesh color, with frequent bands or patches of purple or yellowish brown; sometimes purple with whitish bands.

Carpenter said that this is in some respects the most remarkable species of *Antedon* that he had seen, for it has a very considerable range of variation and has been described under four different names. He called it *Antedon variipinna*, but unfortunately the type specimen of *variipinna* from Borneo represents quite a different species with cylindrical instead of sharply prismatic lower pinnules.

He said that the *Challenger* collection contained two individuals from the entrance to Prince of Wales Channel in Torres Strait that agree with the type of *crenulata* in several points, but they have no IIIBr series at all. One of them has spines on the distal cirrus segments though the cirri of the other are merely carinate. At first sight, he said, it did not seem advisable to unite these two forms under one specific name, since one had IIIBr series and the other lacked them. He therefore gave the *Challenger* specimens the manuscript name *bidentata*, which he later suppressed. He remarked that the same course was taken two years later by Bell who described *Antedon decipiens* with spiny cirri and no IIIBr series, and *A. irregularis* with unarmed cirri and IIIBr series. But their other characters, he noted, especially the short brachials and the lateral projections on the lower pinnules, agree very closely with those of *Antedon crenulata.* He said that Bell appears to have regarded the absence of IIIBr series in *Antedon decipiens* and of cirrus spines in *A. irregularis,* which has IIIBr series, as sufficient to separate both these types from *A. crenulata.*

When he began to revise the endocyclic comatulids with the IIBr series 4(3+4) included in the *Challenger* collection, the descriptions of which had been written five or six years before, Carpenter found that figures of a form closely allied to Bell's *Antedon decipiens* and also of an example of Bell's *A. irregularis,* but without IIIBr series, had already been drawn.[2] Both had been obtained in Prince of Wales Channel and had formerly seemed to him, as the *Alert* specimens from the same locality had seemed to Bell, to represent two different specific types which could not be referred either to *Antedon variipinna* or to *A. crenulata.*

A third form from the Aru Islands also appeared to be new, and Carpenter figured it in the *Challenger* report under the name of *Antedon dubia,* not being quite clear in his mind whether the occurrence of a IIIBr series was normal or merely due to the regeneration of a 10-armed form as is so often the case in *Antedon bifida* and in other species.

Later Carpenter made a critical study of all the *Alert* material and also reconsidered his descriptions of *Antedon variipinna* and of *A. crenulata.* The result was that he found himself unable to discover any characters sufficiently constant to be of specific value as distinguishing *Antedon irregularis* from *A. decipiens,* or any of these three from *A. variipinna* and *A. crenulata.* He remarked that Bell gave no details respecting the relative size of the lower and distal pinnules in *Antedon decipiens* and *A. irregularis* and that after examining his material he found difficulty in attributing the difference to anything more than the size of the individual specimens, those of *A. decipiens* being generally smaller than those of *A. irregularis.* The presence of spines on the cirrus segments of *A. decipiens* and their absence on the more numerous segments of the cirri in *A. irregularis* seemed, however, to be good specific characters. But when he came to examine the gray specimens from Prince of Wales Channel (in reality from *Alert* station 144), which Bell had provisionally regarded as a variety of the white individuals obtained at the same locality because of their cirri being "rather more numerous and more jointed," he found the cirrus segments to be also unprovided with definite spines, although they have the same sharply carinate appearance as those of *A. irregularis.*

The radials of these individuals are also mostly concealed, as is the case in *A irregularis,* though in the type of *A. decipiens* they are "quite distinct" as described and figured by Bell; but they are much less distinct in the white individuals from Prince of Wales Channel. In all the specimens from the last-mentioned locality, therefore, the radials resemble those of *Antedon irregularis* rather than of *A. decipiens;* but some of them had spiny cirri as in the type of *A. decipiens,* while in others the cirrus segments are only sharply carinate as in *A. irregularis.* The arms and pinnules of all the specimens, however, are most like those of *A. decipiens.*

Carpenter said that it would seem impossible, therefore, to make any distinction between the two species on the basis of the characters presented by the arms, the radials, or the cirri, and this conclusion is confirmed by the following considerations:

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[2] *Challenger* Report, Zoology, vol. 26, pt. 60, 1888, pl. 48, figs. 3-5 (form allied to *A. decipiens*), pl. 49, figs. 1, 2 (*A. irregularis*).

The two individuals from the Aru Islands, which he formerly referred to a new species, *Antedon dubia*, have about 35 cirrus segments with the later ones carinate as in *A. irregularis*. But they have relatively large and conspicuous radials with a sculptured surface exactly as in Bell's figured specimen of *Antedon decipiens*, which, like these, has no IIIBr series. The arm bases of the smaller individual from the Aru Islands resemble those of *A. decipiens*, while those of the larger show more of the characters of *A. irregularis*. On the other hand, *A. variipinna* and *A. crenulata* both have IIIBr series and 30 or more spiny cirrus segments, while the radials are fairly distinct, those of *A. crenulata* being more or less sculptured. Neither species has specially rounded arm bases, like those of *A. irregularis*, though the general outline of the ossicles is the same in all the types. Carpenter said that the variation in the characters of all these different forms may be conveniently expressed by letters as follows:

Number of cirrus segments	30 to 35 A	25 a
Character of cirrus segments	Distinctly spiny B	Sharply carinate b
Radials	Distinct C	Mostly concealed c
IIIBr series	Present D	Absent d
Arm bases	Much rounded E	Less rounded e
Arms	Serrate F	Fairly smooth f

He noted that we then get the following expressions to denote the eight forms of this specific type, five of which have been regarded as representing different species:

[1. *Antedon variipinna*	ABCDeF	Canton]
2. *Antedon crenulata*	ABCDef	Borneo
3. *Antedon decipiens* type (*Alert*)	aBCdef	Arafura Sea
4. *Antedon decipiens* var. (*Alert*)	Abcdef	Prince of Wales Channel
5. *Antedon decipiens* var. (*Challenger*)	ABcdeF	Prince of Wales Channel
6. *Antedon irregularis* (*Challenger*)	AbcdEF	Prince of Wales Channel
7. *Antedon irregularis* (*Alert*)	AbcDEF	Torres Strait and Prince of Wales Channel
8. *Antedon dubia* (*Challenger*)	AbCdEF	Aru Islands

Carpenter said that with these facts before us it is difficult to avoid the conclusion that we are dealing with but one specific type, and this conclusion is confirmed by the fact that in all these different forms the general shape of the brachials and the characters of the pinnules are respectively identical, though the latter vary considerably in the degree of development. The distal brachials have the same shape throughout the whole series, as shown in the *Challenger* examples from the Aru Islands and from Torres Strait. On the other hand, the alternating lateral projections of the ossicles in the lower parts of the arms are very marked in the form from Torres Strait, which Bell called *Antedon irregularis*, and it is fairly distinct in those from the Arafura Sea and from the adjacent Aru Islands. But it is comparatively insignificant in the other form from Torres Strait, which has much less convex IBr and IIBr series than the *irregularis* form from the same locality.

Carpenter said that another universal character of all the different varieties he has referred to this species is the large size of the pinnules on the fourth (that is, fifth) and the two or three following brachials, and the lateral projections at the distal ends of their component segments. P_D, when present, is comparatively small, but its successor, P_1, is somewhat larger, though that on the next brachial (P_a) is smaller again. Beyond this point, however, there is much variation. The pinnules of the next three or four brachials are considerably longer and stouter than P_1, being the largest pinnules on the arm. In those arms that spring directly from the IBr axillary, so that there is no P_D, the largest pinnules are usually P_3 and P_c. When, however, a IIIBr axillary is present, the arm borne on its inner face usually has its largest pinnules on the sixth and seventh brachials, while on the outer arm they are usually on the fifth and sixth (P_2 and P_b). But this arrangement is very far from being a constant one. The next two pinnules after the large pair may also be of considerable size and composed of somewhat elongated segments, but in other cases they show a considerable alteration both in the size and in the character of their component segments.

Carpenter noted that the double row of lateral projections on the segments of these proximal pinnules is developed in rather a singular manner. Their basal segments are somewhat flattened against the arm and the upper edge of their broad dorsal surface is sharpened and more or less carinate, while its distal end is marked by a median process of variable prominence. As the following segments lose their flattened appearance and become more rounded the carination of the upper edge develops into a strong blunt process at the distal end of the segment on its inner side, while the mediodorsal prominence passes into a corresponding process on the outer side. There is much variation, however, in the exact nature and mode of development of these processes.

It was remarked by Carpenter that the frequency of the division of the postradial series in this species, and therefore the number of the arms, is subject to great fluctuations. He said that IIIBr series occur only in the single specimen, which he named *Antedon crenulata*, and sometimes also in the form described by Bell as *Antedon irregularis*. A large number of individuals were obtained by the *Alert*, and the majority of them have two or more IIIBr series, though in others, as in the *Challenger* specimen, IIIBr series are entirely absent. Bell gave the number of arms as ranging from 11 to 22, but Carpenter said he seemed to have overlooked one example in which there are 25. The occurrence of an individual with only 11 arms makes it quite possible that a 10-armed variety of this protean type may eventually be discovered. In fact, according to Carpenter, the two individuals that he formerly called *Antedon dubia* are not improbably of this nature. One of them has two IIBr series, and the other only one. But in each case they result from regeneration of the arm at the syzygy between brachials 3+4. This may perhaps have originally supported a IIBr axillary, or it may have given rise to only one arm, which was replaced by two after fracture as it so often the case. Under these circumstances Carpenter thought it safer to assign this species a place among the 10-armed species to which it can definitely be referred if ever an individual is found in which IIBr series are entirely absent. He said that no harm will be done if it never turns up, and should it do so it will run less risk of being baptised as a new species.

The specimens referred to by Carpenter as *Antedon dubia* are simply young individuals undergoing adolescent autotomy. But Carpenter was not aware of this curious and wasteful method of arm reduplication.

Carpenter said that there is one point relating to the extremely variable characters of this species that seemed to him to be of special importance. The variations he described are not altogether due to difference of locality. Varieties 5 and 6 were found associated by the *Challenger* in Prince of Wales Channel. Variety 7, which is only variety 6 with IIIBr series, was found associated with it by the *Alert* both in Torres Strait and in Prince of Wales Channel, and in the latter locality variety 4 was obtained as well. It was therefore evident to Carpenter that the cause of these remarkable variations in one and the same specific type must be attributed to something more than a mere change of local conditions.

The specimen recorded by Dr. Hubert Lyman Clark from off Double Island Point, Queensland, is a fine adult individual with 28 arms. There are about XXV cirri, the longest with 45 segments. The color, dry, is uniformly brownish white.

The three specimens from 10 miles southwest of Mapoon are especially fine. One has 19 arms 150 mm. long, and the cirri XVI, 41–43, from 25 to 30 mm. long. Another has 21 arms 150 mm. long and the cirri with 40–42 segments, 30 mm. long. The third has 17 arms 130 mm. long and the cirri XXIII, 41–44, 30 mm. long In these three specimens the processes on the segments of the lower pinnules are strongly developed and typical. The cirri are more or less carinate distally. The synarthrial tubercles are prominent, so that the animals are characteristically rugose.

Of the two specimens from Port Curtis one has 14 arms 80 mm. long, and the cirri XXIII, 35–40, 30 mm. long. The other has 26 arms 100 mm. long, and the cirri XXIX, 35–45 (usually 40–41), 30 mm. long. The centrodorsal is 5 mm. in diameter at the dorsal pole. The arm bases are exceptionally rugged with the synarthrial tubercles large, prominent, and bluntly conical. The lower brachials are very short but much swollen, with strongly projecting distal edges. The division series are just in apposition laterally. The distal cirrus segments are very strongly and sharply carinate, this carination standing out as a broad spine of which the outer edge is almost or quite parallel with the longitudinal axes of the segments.

The specimen from Mast Head Island is a fine example with 22 arms.

One of the specimens from Baudin Island has the lateral processes on the segments of the proximal pinnules greatly exaggerated. The other is small.

Of the specimens from Holothuria Bank six are large, very rugged, and typical examples with the lateral processes on the segments of the proximal pinnules exceptionally well pronounced. These have 10, 11, 12, 13, 15, and 17 arms. One small specimen has 15 arms. There are also four small 10-armed specimens.

The specimen from the vicinity of York Sound is small.

Dr. H. L. Clark, basing his conclusions on 50 specimens, 30 dredged at various points near Broome in 9–15 meters, 18 from on or near Pearl Shoal in 9–15 meters, and 2 from Norwest Islet in the Capricorns, said that the number of arms ranges from 16 to 30, but the great majority of individuals with arms over 60 mm. long have 20 to 25. The cirri are XX–XXXII, 34–46, but small individuals often have fewer segments. The largest specimens have the arms 75–90 mm. long. There is great diversity in the development of the projections on the segments of the basal pinnules; often they may best be designated as spines, but in other cases they must be characterized as "wings." Light-colored individuals seem on the whole to tend toward wings, while the dark-colored ones are more spinous. The correlation is, however, very imperfect.

Dr. Clark said that one very small comatulid, apparently a *Heterometra*, and hence almost surely this species, was taken in 1932 at Broome. There are 13 arms about 15 mm. long. The division series are 4(3+4), but the cirri are only X, 13. The color is very pale brown, the cirri with a very slight tinge of violet.

The single specimen from Mjöberg's station 7 and the two from his station 11 were thus described by Dr. Torsten Gislén: The centrodorsal is thickly discoidal with an almost flat papillated dorsal surface which is from 3 to 4 mm. in width. The cirrus sockets are arranged in two rows. In two of the specimens the cirri are XXIX, 33–46, the marginal cirri being 38–46 and those of the distal row having 33–39 segments. The length of the cirri is 25 to 30 mm. Included in the number of the cirri are some empty fresh sockets from several of which young cirri are regenerating. In the marginal cirri dorsal carination begins at the nineteenth–twenty-first segment (in an exceptional case at the twelfth) while in the cirri of the distal row it begins at the fourteenth–sixteenth. The third specimen has the cirri XXXV, 35–40; the dorsal carination first appears on the very last segments. The proximal cirrus segments are laterally flattened, and the distal are laterally compressed. The longest proximal segments are one-third again as broad as long, and the distal segments are twice as broad as long. The first segment is short, four times as broad as long. The opposing spine is usually a little stronger than the spines on the preceding segments. The terminal claw is curved, and is at least as long as the penultimate segment.

The anterolateral angles of the radials project as small triangular portions between the bases of the cirri and the IBr_1. Their surface is strongly granulated—they are almost completely concealed by the centrodorsal, however, in the specimen from station 7. The IBr_1 are laterally in contact. The IBr_1 and IBr_2 are united by synarthry, each having a median tubercle. This points directly up on the IBr_1 but is bent backward on the IBr_2 so that the two tubercles converge to a joint tip. This is repeated on all the pairs of ossicles united by synarthry. The IIBr series are 4(3+4), in exceptional cases four arranged in two synarthrial pairs; in the latter case each pair of ossicles shows a synarthrial tubercle. In the specimen from station 7 two of the IIBr series are 2. The IIIBr series are 2, in a few cases 2(1+2). The ossicles following the axillaries are united interiorly. The syzygies in the division series unite a very short discoidal hypozygal and an irregularly triangular epizygal—the axillary. The division series and arm bases are in close lateral apposition, but they are little flattened laterally. The elements of the division series and the proximal brachials are plump and swollen.

The three specimens have 23, 24, and 30 arms, 85 to 100 mm. in length. The first 10 brachials are discoidal and those following become wedge-shaped, and again discoidal in the distal portion of the arms. From the seventh or eighth brachials onward there are thick transverse dorsal prominences (articular tubercles), which are developed most strongly on the side of the segment that carries the pinnule, thus alternating on the right and left sides. The distal segments are collar-shaped.

Gislén gave the distribution of the syzygies in a typical postradial series. The IBr series is 2. The two IIBr series are 4(3+4). There are two IIIBr series, both internally developed, one 2 and the other 2(1+2). On one of the outermost arms, arising from a IIBr axillary, the syzygies are between brachials 3+4, 12+13, and

20+21; on the other outermost arm they are between brachials 3+4, 13+14, and 26+27. On one of the two arms arising from the IIIBr 2 series the syzygies are between brachials 3+4, 10+11, and 18+19, and on the other they are between brachials 3+4, 15+16, and 26+27. On one of the two arms arising from the IIIBr 2(1+2) series the syzygies are between brachials 3+4, 11+12, and 24+25, and on the other they are between brachials 3+4, 15+16, and 27+28. The distal intersyzygial interval is from 13 to 21 muscular articulations.

P_D is 6 mm. long with 21 segments of which the first is short and the second–tenth are about as long as broad with prominences directed outward (toward the arm tip); the distal segments are shorter with the inner margin provided with low knots. The whole pinnule is compressed and twisted a quarter of a turn. P_1 is 7 mm. long, with 21 segments, very much stouter and stronger than P_D. The first two segments taper distally, and are somewhat longer than broad. From the second segment onward there is a sharply marked crest directed toward the arm tip. From the sixth segment the carination branches, and from this point to the fifteenth segment the pinnule is rather pronouncedly two or three edged. The sixteenth–twentieth segments are more rounded with thickened spinous borders distally. P_2 is 8–10 mm. long, with 18 segments of which the first two are without out-turned prominences and the remaining segments have large and very spiny processes which on the last eight form a spiny garland around the distal part of the segments. This garland also appears, though still more delicately developed, up to P_{10}. P_3 is 11 or 12 mm. long, with 16–18 segments. P_4 is 7–9 mm. long, with 12 segments. P_{11} is 7 mm. long, with 15 segments. P_a is rather short, corresponding to P_D. The longest pinnule is P_b. P_c is a little shorter than P_b. The disk is without calcareous concretions or plates. The color in life was minium red; in alcohol it is the same but fainter.

This description is not altogether clear, but it cannot apply to any species other than the one under consideration. Gislén discussed the relationship between *variipinna* and *crenulata* at considerable length, but in his discussion makes no mention of the differences in the proximal pinnules by which the two species are easily distinguished.

The specimens from *Siboga* station 273 exactly resemble others from northwestern Australia. The arms are stout, basally strongly flattened laterally, and very rugose. The lateral processes on the pinnule segments are very strongly developed. One very fine typical example has 22 arms 120 mm. long. All the IIBr series are 4(3+4), and both the IIIBr series are 2 and are internally developed. The color is white, with the outer part of the pinnules and the cirri violet. Another has 20 arms 110 mm. long. Two of the IIBr series are absent, the eight present being 4(3+4); the two IIIBr series, both of which are internally developed, are 2. The color is similar to that of the preceding, but there are in addition a few narrow purple bands and blotches on the outer part of the arms. A third has 16 arms 120 mm. long. There are five IIBr 4(3+4) series and one IIIBr 2 series, the latter internally developed. A fourth has 16 arms 115 mm. long. There are six IIBr 4(3+4) series. The three remaining examples are similar.

The two specimens from *Siboga* station 274 are small. The larger has 13 arms 75 mm. long. There are three IIBr 4(3+4) series on three separate postradial series. The animal is flesh colored with regular narrow purple bands on the arms.

The specimen collected by Dr. Merton in the Aru Islands was thus described by Reichensperger: The centrodorsal is somewhat hemispherical, convex, the free dorsal pole about 3 mm. in diameter and sculptured with fine pits. The cirri are arranged in two or three irregular rows. The cirri are XXXIII, 40–42, about 35 mm. in length. None of the cirrus segments are longer than broad; the middle ones are about as long as broad and they bear toward the end a prominent dorsal keel. The antepenultimate segment is toothed. The terminal claw is short and not very stout, but sharp. When viewed from above the cirri are seen to be somewhat less sharply pointed than those of *Craspedometra acuticirra,* although they have in general great similarity to the cirri of that species. The radials are visible for the most part only in the interradial angles of the calyx where their adjoining anterolateral corners are to be seen. The IBr_1 are very broad and short, about five times as broad as long. The IBr_2 (axillaries) are shortly pentagonal. The IIBr series are always 4 (3+4); they are composed of short rugose elements which appear as if laterally compressed at the articulations. This lateral compression is continued to the eighth or tenth segment of the free undivided arms. When present the IIIBr series are 2; the first segment is short discoidal, evenly convex dorsally, and the axillary is half again as long and pentagonal. There are no further division series. The first elements of each division series are laterally united. There are 22 arms which are up to 130 mm. long. The arms gradually taper distally. The 9 or 10 lowest brachials are discoidal, short, and laterally compressed; those following become more and more wedge-shaped and distally markedly convex dorsally, with the distal ends laterally and dorsally produced so that the middle portion of the arm is very uneven. The distal brachials are much more even and are short and discoidal. The first syzygy is between brachials 3+4, and the second is somewhere between brachials 12+13 and brachials 15+16.

P_D is short, 10–12 mm. long, and is composed of 25–28 segments, which at first are broader than long, in the middle of the pinnule about as long as broad, and later broader again. The pinnule is but little stiffened and becomes slender and somewhat moniliform distally. P_1 is longer than P_D, of similar form but stiffer, 16–17 mm. long; the component segments are relatively markedly longer than those of P_D. P_2 is stiff, 19–20 mm. long, with 24–26 segments. It tapers gradually and the distal portion is recurved and finally pointed. The three basal segments are broader than long, the fourth is about as long as broad, and those following, if the pinnule is viewed laterally, are longer than broad. P_3 is similar to P_2 but markedly stouter and prominently keeled. It is up to 23 mm. long and is composed of 26–28 segments. P_D to P_5 are basally, and P_1 to P_3 are also farther out, prominently carinate. The latter have on the outer side of the segments from the third onward lateral processes involving the distal half of the segments which increase in size distally. P_4 and a number of the succeeding pinnules are straight, rather stiff, of approximately the same length, 11 mm., and composed of 16–18 segments which except for three or four of the basal are longer than broad. On individual arms P_5 may be the smallest pinnule, only from 9 to 10.5 mm. long. From this point the size very slightly increases to about 13 mm. in the distal portion of the arms. All the pinnules in about the proximal half of the arms seem to be rather stiff, and this, taken in connection with the uneven dorsal sculpture of the arms, gives the animal a robust and spiny appearance. The disk is lacking. The color is white, the tips of the cirri dorsally and the ambulacral grooves tinged with violet.

This specimen was recorded by Dr. Reichensperger under the name of *Craspedometra anceps*, but he referred it to this species with reservations and suggested that if it proved to represent a new species, as he was fairly sure it would, it might bear the name of *Craspedometra aruensis*. He said that it could not be confused with *acuticirra* (from Sydney) or with *amboinae*, but that it bears a certain similarity to *anceps* although the cirri are about twice as numerous and are composed of more numerous segments, the pinnules are markedly longer with more numerous segments and are quite different in their relative length and stoutness, while it seemed to him that the lateral compression of the brachials and the strong convexity of the distal portion of the arms are in no previously described species so pronounced as they are in this specimen. The figure he gave of the lower pinnules shows that these are of the type characteristic of, and peculiar to, *H. crenulata*, and the description in all its details applies perfectly well to certain forms of this highly variable species.

Professor Koehler's specimen from Biliton was much mutilated, most of the arms having been broken off while only a single cirrus remained intact. There were XXII cirri. The radials are barely visible. There are one or two IIIBr series on each postradial series—six IIIBr series in all. Presumably, therefore, there were 26 arms. The dorsal surface of the elements of the IBr series, the two first elements of the IIBr series, the IIIBr series, and the first two brachials is strongly sculptured. The lateral borders of the brachials are swollen and prominent. The second syzygy is at about the sixteenth brachial. P_1 is very small, with at the most 25 segments. The pinnules following, which are larger, bear lateral processes on their segments which have the form of those figured by Bell for his *Antedon irregularis*. The general color is gray.

The specimen from Pocock Island has 20 arms 110 mm. long. Three IIBr series are lacking, but this deficiency is compensated by the development of three IIIBr series. The seven IIBr series are extraordinarily irregular. One is 8 (3+4; 5+6; 7+8), one is 2, one is 4 with the two distal elements united by synarthry, and four are 4 (3+4). The three IIIBr series are also irregular; one is 1, one is 2, and one is 4 (3+4), the last two being on a single postradial series on which the IIIBr 2 series is internal and the IIIBr 4 (3+4) series external. This example agrees with others from Singapore in the collection of the Copenhagen Museum, and with others from Australia in the collection of the Australian Museum.

The specimen from South Nilandu recorded by Bell I have not seen. He said that it was taken among living corals at the seaward end of a passage, but gave no notes on it. I have grave doubts concerning the correctness of the determination, as the Maldive archipelago lies considerably west of the Andamans, which represent the western limit of the range as outlined by specimens I have been able to examine.

Color in life.—Dr. H. L. Clark wrote that some half dozen specimens dredged on Pearl Shoal outside Roebuck Bay seemed at the moment the most lovely comatulids he had ever seen. The arms were a pure milk-white, the cirri bright rose-red in sharp contrast. The somewhat rigid arms remained curved outward like the petals of a flower, and the old book name "sea-lily" was most appropriate. He subsequently dredged other specimens the coloration of which was so different that they were not even suspected of being the same species. In 1932 he met with *Heterometra* often, and the diversity of color led to the supposition that he was collecting three different comatulids.

Dr. Clark says that according to coloration three forms may be recognized, but with sufficient material it is obvious that they intergrade completely. At one extreme are the milk-white forms with rose-colored cirri. When preserved in alcohol or dried these lose much of their beauty, the white becoming dingy or tinged with purple and often small spots or bloches of a purplish shade appear. At the other extreme are the individuals, usually large ones, that are deep red-purple or dark crimson with few or no lighter markings; these commonly have a coarser and more rugged structure than the white ones. The third group includes the more or less handsome individuals with banded arms; these may be white, or at least very light, as to ground color with the arms banded with red or purple of some shade, or they may be red or purple with whitish bands and markings. The number, width, and shade of the arm bands show endless diversity. The cirri are always red or purple of some shade, ranging from light rose to a deep red-violet. One very small specimen with 13 arms about 15 mm. long was very pale brown, the cirri with a very light tinge of violet.

Abnormal specimens.—In the specimen from Pocock Island one of the IIBr series is 8(3+4; 5+6; 7+8), one is composed of four elements united in two synarthrial pairs, and one is 2; of the three IIIBr series one is 1, one is 2, and the third is 4(3+4).

Gislén recorded a specimen from Mjöberg's station 7 with a IIBr series consisting of four ossicles united in two synarthrial pairs and a IIIBr 2(1+2) series.

In the specimen from Tonkin described by Gislén one of the IBr series is 6(5+6).

In the specimen from Annam an external arm arising from a IIBr 4(3+4) axillary has the first syzygy between brachials 4+5; another arm on the same postradial series arising from the inner side of a IIIBr 2 axillary has the first syzygy between brachials 7+8; a third arm on the same postradial series arising from the IBr axillary has syzygies between brachials 3+4, 5+6, and 7+8.

Remarks.—This species reaches its extreme development (form *irregularis*) on the coast of Australia, where the individuals are usually large and rugged with numerous arms and with the characteristic features of the enlarged proximal pinnules highly developed and often exaggerated. Northward the individuals become less extremely developed and are usually smaller with fewer arms, more slender, and less rugged, with the characteristic features of the proximal pinnules moderately developed. This is the typical form (*crenulata*) that occurs throughout the range of the other forms, except perhaps in the extreme south, and is the prevailing form at Singapore and in the Philippine Islands. From the Aru Islands to the Philippines the species occurs in a still more slender form (*aliena* [=*aruensis*]) in which the cirri are merely slightly carinate distally and the processes on the segments of the enlarged proximal pinnules are only very feebly developed.

Bell's name *decipiens* and Carpenter's names *bidentata* and *dubia* were applied to young individuals of the highly developed form called *irregularis* by Bell.

Basing his conclusions on specimens from Tonkin, Annam, and Cambodia Gislén says that evidently northward this species tends to pass over into *H. variipinna*, from which it seems scarcely to be distinguishable as a good species.

Localities.—*Albatross* station 5481; between Samar and Leyte, Philippines, in the vicinity of Surigao Strait; Cabugan Grande Island (N.) bearing N. 86° W., 3.8 miles distant (lat. 10°27′30′′ N., long. 125°17′10′′ E.); 111 meters; sand, shells, and gravel; July 30, 1909 [A. H. Clark, 1911].

?Near Bohol, Philippines; Prof. Carl Semper [von Graff, 1877, 1884; P. H. Carpenter, 1888; A. H. Clark, 1912].

Albatross station 5385; Jolo (Sulu) Sea; Sandakan Light bearing S. 34° W., 19.7 miles distant (lat. 6°06′40′′ N., long. 118°18′15′′ E.); 71 meters; mud; January 7, 1909 [A. H. Clark, 1911].

Albatross station 5157; Tawi Tawi group, Jolo Archipelago; Tinakta Island (N.) bearing S. 80° W., 3.3 miles distant (lat. 5°12′30′′ N., long, 119°55′50′′ E.); 33 meters; fine sand; February 21, 1908 [A. H. Clark, 1908, 1909] (2, U.S.N.M., 25516, 35197).

Philippine Islands [A. H. Clark, 1911, 1912]. This refers to the four preceding records.

Neighborhood of Borneo [P. H. Carpenter, 1882, 1888; A. H. Clark, 1912].

Off southeastern Borneo (lat. 3°12′ S., long. 116°38′ E.); 14–19 meters [A. H. Clark, 1933] (1, Buitenzorg Mus.).

Along Bay, Tonkin; Dr. C. Dawydoff [Gislén, 1936].

Nha'trang Bay, Binh Damon (Tre Island), Annam; Dr. C. Dawydoff [Gislén, 1936].

Off Phuquoc, Duougdong, Cambodia; Dr. C. Dawydoff, February 11, 1930 [Gislén, 1936].

North of central Java (lat. 5°22′ S., long. 109°21′ E.); November 21, 1907 [A. H. Clark, 1933] (4, Buitenzorg Mus.).

North of western Java (lat. 5°22′ S., long. 107°42′ E.); 23 meters; November 15, 1907 [A. H. Clark, 1933] (2, Buitenzorg Mus.).

Off Cape Jabung, northern coast of southern Sumatra (lat. 1°03′ S., long. 104°35′ E.; July 3, 1908 [A. H. Clark, 1933] (2, Buitenzorg Mus.).

Singapore; Svend Gad [A. H. Clark, 1909, 1911, 1912] (6, C.M.).

Northeastern Australia; Prof. J. Beete Jukes; H.M.S. *Fly*, 1843–1847 [A. H. Clark, 1913] (1, B.M.).

Alert station 144 (probably Thursday Island) [Bell, 1884].

Alert; Torres Strait; 18 meters; sand; also without mention of depth [Bell, 1882, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1912, 1913] (16, B. M.).

Alert; Prince of Wales Channel, Torres Strait; 9–13 meters[3]; 13 meters, sand; 13–16 meters; and without mention of depth [Bell, 1882, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1912, 1913] (74, B. M.).

Challenger station 186; Prince of Wales Channel (lat. 10°30′ S., long. 142°18′ E.); 15 meters; coral mud; September 8, 1874 [P. H. Carpenter, 1888; A. H. Clark, 1911, 1912, 1913] (2, B. M.).

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[3] Given in Mem. Australian Mus., vol. 4, 1911, p. 765, as "Torres Strait, in 5–7 fathoms."

Challenger station 187; off Booby Island (lat. 10°36′S., long. 141°55′ E.); 11 meters; coral mud; September 9, 1874 [P. H. Carpenter, 1888].[4]

Albany Island [A. H. Clark, 1912].

Three miles north by west of Double Island Point, Queensland (South of Maryborough); 46–47 meters [H. L. Clark, 1916] (1, Australian Mus.).

Ten miles southwest of Mapoon; 18 meters [A. H. Clark, 1911] (3, Australian Mus.).

Port Curtis, Queensland [A. H. Clark, 1911, 1912] (2, Australian Mus.).

Masthead Island, Capricorn group (off Port Curtis) [A. H. Clark, 1911] (1, Australian Mus.).

Norwest Islet, Capricorn group; 11 meters; Boardman and Livingstone, December 1930 [H. L. Clark, 1938].

Alert; Dundas Strait (entrance to Van Diemen Gulf) northern Australia; 31 meters; mud [Bell, 1882, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1912, 1913] (1, B. M.).

Alert station 160; Arafura Sea; 58–66 meters; mud, sand, and shells [Bell, 1882, 1884; P. H. Carpenter, 1888; A. H. Clark, 1912, 1913] (1, B. M.).

Baudin Island, northwestern Australia [Bell, 1894; A. H. Clark, 1911, 1912, 1913] (1, B. M.).

Baudin Island; 15–27 meters [A. H. Clark, 1929] (1, B. M.).

Holothuria Bank, northwestern Australia; 44 meters [Bell, 1894; A. H. Clark, 1911, 1912, 1913] (6, B. M.).

Holothuria Bank; 69 meters [Bell, 1894; A. H. Clark, 1911, 1912, 1913] (4, B. M.).

Northeast of Holothuria Bank; 27–36 meters [Bell, 1894; A. H. Clark, 1911, 1912, 1913] (1, B. M.).

Northwestern Australia [A. H. Clark, 1912]. This refers to the 5 preceding records.

Vicinity of York Sound, northwestern Australia (lat. 14°50′ S., long. 125°40′ E.) [A. H. Clark, 1913] (1, B. M.).

Broome, Western Australia; dredged at various points in 9–15 meters; H. L. Clark, June 1932 [H. L. Clark, 1938].

Pearl Shoal, off Broome; 9–15 meters; H. L. Clark, September 1929 [H. L. Clark, 1938].

Dr. Eric Mjöberg's station 7; northwestern Australia; Cape Jaubert 45 miles westsouthwest; 13 meters; July 15, 1911 [Gislén, 1919].

Dr. Eric Mjöberg's station 11; northwestern Australia; Cape Jaubert 45 miles westsouthwest; 22 meters; July 17, 1911 [Gislén, 1919].

Challenger; Aru (Arrou) Islands [P. H. Carpenter, 1888; A. H. Clark, 1912, 1913] (3, B. M.).

Siboga station 273; anchorage off Pulu Jedan, eastern coast of the Aru Islands (pearl banks); 13 meters; sand and shells; December 23–26, 1899 [A. H. Clark, 1918] (7, U.S.N.M., E. 468; Amsterdam Mus.).

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[4] This locality is not included in the list of localities given under *Antedon variipinna* in the *Challenger* report, nor is the species given in the list of species secured at station 187. But on page 97 of that report, under *Antedon multiradiata, Antedon bidentata* was given as "the other species dredged at that locality" [station 187].

Siboga station 274; off the northeastern coast of the Aru Islands (lat. 5°28′12″ S., long. 134°53′54″ E.); 57 meters; sand, shells, and stones; December 26, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Aru Islands; Dr. H. Merton's station 1; west of Ngaiguli; 14 meters; coarse yellow sand; February 18, 1908 [Reichensperger, 1913].

Biliton, Sunda Islands; M. Korotnev, 1885 [Koehler, 1895; A. H. Clark, 1912 (as Sunda Islands)].

Investigator; Pocock Island, southeast of Cape Price, the northernmost point of Great Andaman Island (lat. 13°33′40″ N., long. 93°00′30″ E.); 36 meters [A. H. Clark, 1912] (1, I. M.).

?South Nilandu, Maldive archipelago; 38 meters [Bell, 1902].

Erroneous locality.—Mergui Archipelago [A. H. Clark, 1911]. This is an error for Andaman Islands.

Geographical range.—From the Philippine Islands southward to Australia, reaching Double Island Point, Queensland, and Cape Jaubert, Western Australia, and westward to the Andaman Islands, and possibly to the Maldive archipelago.

Bathymetrical range.—From the shoreline down to 111 meters. The average of 21 records for which a definite depth is given is 35 meters.

History.—Prof. Ludwig von Graff in 1877 recorded some myzostomes from a comatulid from Bohol in the Philippines, which had been given the manuscript name of *Comatula dubia* by Prof. Carl Semper, who had collected it a few years before. What this *Comatula dubia* was is not at all clear. Prof. von Graff referred to it again as *Antedon dubia* in 1884, and Carpenter later used the name *Antedon dubia* for the present species as will appear below. Previously, therefore, I have assumed that Semper's *Antedon dubia* was the same as Carpenter's *Antedon dubia.* But as Carpenter never mentioned the former, did not include the Philippines among the localities from which the species under consideration was known to him, and gave the Aru Islands as the only locality for the form which he called *Antedon dubia,* I now believe that the *dubia* of Semper and the *dubia* of Carpenter must have been two different species and that the former should not be included in the synonymy of the present species, but instead should be placed in the list of unidentifiable forms. Semper's *dubia* is mentioned here, however, because it has so long been, on what I now believe to have been quite insufficient grounds, included in the synonymy of this species.

The present species was first described by Dr. P. H. Carpenter under the name of *Antedon crenulata* on September 26, 1882, his description having been based upon some dried fragments he had studied in the Hamburg Museum.

Five days after this, on October 1, 1882, Prof. F. Jeffrey Bell published specific formulas for two new species which he called *Antedon decipiens* and *Antedon irregularis,* but he gave no indication of their habitat or of their origin.

In the report upon the collections of H. M. S. *Alert* published in 1884 Professor Bell described and figured *Antedon decipiens* from specimens secured in the Arafura Sea (32–36 fathoms), Dundas Strait, and Prince of Wales Channel. He provisionally associated with this species, as a variety, two specimens that had been dredged at station 144, identified some pages farther on (page 167) in a footnote under *Actinometra robusta* as probably Thursday Island. *Antedon decipiens,* he said, presents some resemblances to Carpenter's *Antedon pinniformis.* In the *Alert* report he also described and figured *Antedon irregularis* from specimens secured in the Prince of Wales Channel and in Torres Strait. He remarked that *irregularis* has some resemblance to *decipiens*, and gave what he considered the distinguishing characters.

In 1884 Professor von Graff described the myzostomes found on a specimen from *Challenger* station 186, the name of the host having been given him by Carpenter as *Antedon bidentata*. This name appeared again in a notice of myzostomes published in the *Challenger* narrative in 1885, and in a second contribution on the myzostomes by Professor von Graff published in 1887. Carpenter also used it in an article containing an account of the sacculi in the comatulids published in 1887.

In the *Challenger* report upon the comatulids published in 1888 Carpenter gave an exhaustive account of this species—quite the best account that he gave of any comatulid. His description was drawn up from two specimens from *Challenger* station 186 and two more collected by the *Challenger* at the Aru Islands. He used the name *Antedon variipinna* for the species, including as synonyms under this name his own *Antedon crenulata* and the *Antedon decipiens* and *A. irregularis* of Bell. Unfortunately he overlooked the fact that in the descripion of *Antedon variipinna* he had said that "the distal ends of the cylindrical joints of the large lower pinnules are raised into slight spines," which indicates a species quite different from a form with sharply prismatic pinnules such as his *A. crenulata* and the two forms described by Bell.

In his account of *Antedon multiradiata* (=*Zygometra microdiscus*) he mentioned that *Antedon bidentata* had been secured at the same station (station 187), but he did not include this station among the localities under *Antedon variipinna*. At the very end of his account of *Antedon variipinna* he said that the single example of *A. variipinna*, var. 5 (given in the list of varieties as "*Antedon decipiens*, var. [*Challenger*]") from the Prince of Wales Channel was serving as host to 14 individuals of myzostomes, and that the name of the host was given in Professor von Graff's report as *Antedon bidentata*, this being the manuscript name he had applied to it before he had become convinced of its identity with *Antedon variipinna* or had had the opportunity of identifying it with Bell's *A. decipiens*. Von Graff, however, gave the locality of this specimen as station 186 instead of station 187 as it was given by Carpenter.

Carpenter mentioned *Antedon dubia* several times. He gave it as an example of a 10-armed species occasionally varied by the intercalation of IIBr 4(3+4) series, and as a species in which the second and third pairs of pinnules are especially characterized by their large size, and he figured it under that name on plate 36, figures 1–6. While he had regarded it as a distinct species when the earlier pages of the *Challenger* report were going through the press, before the account of *Antedon variipinna* was ready to be printed he had reached the conclusion that it is merely a synonym of that species. Under *Antedon variipinna* he said that he had formerly referred the two individuals from the Aru Islands to a new species, *Antedon dubia*, and discussed them at some length.

In 1894 Prof. Jeffrey Bell recorded this species, under the name of *Antedon variipinna*, from northwestern Australia in 9–38 fathoms, and in 1895 Prof. René Koehler under the same name recorded a specimen collected at Biliton by M. Korotnev in 1885 and gave notes on the specimen. Professor Bell in 1902 recorded it from South Nilandu in the Maldives.

In my first revision of the old genus *Antedon* published in 1907 I assigned this species to the new genus *Himerometra*, calling it *Himerometra variipinna*, and in 1908 I recorded a specimen from *Albatross* station 5157 under that name.

In a revision of the genus *Himerometra* published in 1909 this species was referred to the new genus *Amphimetra* as *Amphimetra variipinna*. Later in the same year it was recorded from Singapore under this name and notes were given on the specimens.

In 1909 I described a new species based upon two specimens from *Albatross* station 5157 which I called *Craspedometra aliena;* this supposed new species later proved to be nothing but very slender examples of this species.

In 1911 I recorded specimens from *Albatross* stations 5358 and 5481 under the name of *Amphimetra variipinna*, and in the same paper, under the heading *Craspedometra anceps*, said that an examination of the *Challenger* types in London had shown me that Carpenter's *Antedon clemens* is the same thing as his *A. anceps* and my *Craspedometra aliena*.

In a memoir on the recent crinoids of Australia published in 1911 I recorded and gave notes upon a number of specimens in the collection of the Australian Museum, and in giving the range of the species I included the details of the localities represented in the British Museum. In this report the locality Mergui Archipelago was given by mistake for Andaman Islands, Pocock Island, taken from the label of an unrecorded specimen in the Indian Museum, being the place referred to. In a memoir on the collection of the Hamburg Southwest Australian Expedition published at the same time I included a detailed summary of the distribution of this species on the Australian coasts, also including the data from the specimens in the British Museum.

In my memoir on the crinoids of the Indian Ocean published in 1912 I recorded and gave notes upon a specimen from Pocock Island in the Andamans, and included in the synonymy of this species for the first time *Comatula dubia* von Graff, 1877, *Antedon bidentata*, and *Antedon dubia* P. H. Carpenter, 1888. A complete list of the known localities was given.

In the same year, having examined the type of Carpenter's *Antedon variipinna* at the Hamburg Museum in 1910, I published a redescription of it showing that it does not represent the species previously called *variipinna*, but instead, so far as I could see, represents the species subsequently called *Antedon brockii* by Hartlaub. I therefore called this species *Amphimetra crenulata*, remarking at the same time that I had unfortunately overlooked the type of this form while at Hamburg. In a supplementary report on the crinoids collected by the Hamburg Southwest Australian Expedition published in 1913 I repeated this information.

Dr. August Reichensperger in 1913, misled by my erroneous disposition of *Craspedometra aliena* in 1911, determined as *Craspedometra anceps* an interesting specimen collected by Dr. H. Merton in the Aru Islands. He described this specimen in detail and figured the proximal pinnules. He was somewhat doubtful in regard to the correctness of this determination, and was rather of the opinion that it would turn out to be a new species for which he suggested the name *Craspedometra aruensis*.

Under the name *Amphimetra crenulata* I published in 1913 notes on the 17 lots of specimens, all but one of which had previously been studied by Bell or Carpenter, or both, in the British Museum, and in 1915 I again discussed the distribution of this species on the Australian coasts.

In 1916 Dr. Hubert Lyman Clark recorded a fine adult from off Double Island Point, Queensland, the southernmost known locality on the eastern coast of Australia.

In the report on the unstalked crinoids of the *Siboga* expedition published in 1918 I assigned *crenulata* to the genus *Heterometra*, and in a footnote to the key to the species of *Heterometra* said that *crenulata* includes *Comatula dubia* von Graff, 1877, *Antedon decipiens* and *A. irregularis* Bell, 1884, *Antedon bidentata* von Graff, 1884, *Antedon dubia* P. H. Carpenter, 1888, and *Craspedometra aliena* A. H. Clark, 1909, with the exception of the 10-armed specimen mentioned in the description of the last named. I also said that this species has usually been recorded as *Antedon* (or *Amphimetra*) *variipinna*, but it is not *Antedon variipinna* P. H. Carpenter, 1882. Under *Heterometra crenulata* I recorded and gave notes on nine specimens from *Siboga* stations 273 and 274.

Dr. Torsten Gislén in 1919 recorded and gave notes on specimens from Dr. Eric Mjöberg's stations 7 and 11 in northwestern Australia. He called the species *Amphimetra variipinna* and included in the synonymy *Antedon variipinna* P. H. Carpenter, 1882, *A. crenulata* P. H. Carpenter, 1882, *A. decipiens* Bell, 1884, *A. irregularis* Bell, 1884, *A. dubia* P. H. Carpenter, 1888, and *A. brockii* Hartlaub, 1890, and discussed the status of *variipinna* and *crenulata* at considerable length; but he overlooked the fact that Carpenter mentioned the cylindrical segments of the large lower pinnules in *variipinna*. Under the name *Amphimetra crenulata* he discussed the structure of this species at considerable length in 1924.

In 1929 I recorded a specimen, as *Heterometra crenulata*, from Baudin Island in 8–15 fathoms. This specimen is in the British Museum. In 1933 I recorded and gave notes on nine specimens in the Buitenzorg Museum from Borneo, Java, and Sumatra.

In 1936 Gislén recorded and gave notes on a specimen from Tonkin, another from Annam, and a third from Cambodia.

In 1938 Dr. H. L. Clark recorded and gave notes on 48 specimens collected by himself at Broome, Western Australia, and 2 collected by Boardman and Livingstone at the Capricorn Islands, Queensland.

HETEROMETRA PRODUCTA (A. H. Clark)

PLATE 26, FIGURE 106

Himerometra producta A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 224 (description; Singapore).

Amphimetra producta A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Vid. Medd. Nat. Foren. København, 1909, p. 157 (description; Singapore), p. 193 (collected at Singapore by Svend Gad); Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 31 (compared with *A.* [*Heterometra*] *propinqua*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 17 (compared with *A. variipinna* [*Heterometra crenulata*]); Crinoids of the Indian Ocean, 1912, p. 40 (=*Antedon laevissima* Bell, 1902, in part, and *Antedon milberti* Bell, 1902, in part), p. 111 (synonymy; Singapore; Fadiffolu, Maldives); Smithsonian Misc. Coll., vol. 61, No. 15, p. 23 (Fadiffolu; characters).

?*Antedon laevissima* Brit. Mus., MS. A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 23 (Fadiffolu, Maldives).

Heterometra producta A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 99 (range), p. 103.

Diagnostic features.—The enlarged proximal pinnules are rather slender and become flagellate distally; their basal segments are sharply carinate, and the segments from the third onward have the entire distal end somewhat produced and overlapping, the outer portion of the prismatic ridges being produced into a blunt spine which is directed obliquely forward. The cirri have 23–26 segments of which the longest are half again as long as broad, and the outer are about as long as broad. The 10–13 arms are 50 mm. long.

Description.—The centrodorsal is low hemispherical, almost discoidal; the polar area is moderate in size with a raised and roughened center. The cirrus sockets are arranged in two crowded alternating rows, beyond which are one or two rows of more or less obliterated sockets.

The cirri are XVI, 24–26, slender, 15 mm. long. The first three segments are very short, the fourth is not quite twice as broad as long, the fifth-eighth are half again as long as broad, and those following gradually decrease in length, after the tenth or eleventh being about as long as broad. The ninth and following segments are sharply carinate dorsally, and on some of the cirri bear small subterminal dorsal spines. The opposing spine is terminal, rather large, and arises from the whole dorsal surface of the penultimate segment, its distal edge being a continuation in a straight line of the distal edge of that segment. The terminal claw is somewhat longer than the penultimate segment, rather slender and moderately curved.

The radials are short, with the middorsal line parallel to the dorsoventral axis of the animal. The IBr_1 are very short, four or five times as broad as long. The IBr_2 (axillaries) are broadly pentagonal, rather over twice as broad as long, rising to a slight smooth rounded tubercle with the IBr_1. Three IIBr series are present in the type specimen, all 4(3+4).

The 13 arms in the type specimen are 50 mm. long. The first two brachials are wedge-shaped, the next six are oblong, three or four times as broad as long, and those following are short wedge-shaped, after about the middle of the arm becoming oblong again and very short.

P_1 is slender, becoming flagellate distally, 5 mm. long with 17-20 segments of which the first is not so long as broad, the second-fifth are about as long as broad, and those following become elongated and about twice as long as broad distally; the first seven or eight segments are somewhat carinate. P_2 is similar to P_1, 7 mm. long, with the distal segments somewhat longer and the carination of the basal segments more marked. In addition to the dorsal carination there is a lateral carination, which is only slightly marked on P_1, especially evident toward the end of each segment. P_3 is comparatively stout and stiff, 8 mm. long with 12 segments of which the first is not quite so long as broad, the second is about as long as broad, and those following become elongated, being about three times as long as broad distally. The second-fifth segments have a sharp dorsal keel, and from the third onward the median portion of the outer surface of the distal ends of the segments is produced, forming a moderate lateral process of the type seen in *H. crenulata*, which is repeated, less developed, on the opposite side of the pinnule. In the distal portion of the pinnule the entire distal end of the segments is somewhat overlapping. P_4 and the following pinnules are 4 mm. long with 12 segments increasing in length to the third, which is about as long as broad, then increasing distally to about three times as long as broad, the three or four terminal being shorter again. The distal pinnules are 6 mm. long.

The color in alcohol is flesh color, clouded with violet.

Notes.—I am not wholly convinced that the specimen from the Maldive Islands should be referred to this species. It has only 10 arms. There are 23–25 cirrus segments, which from the tenth onward bear small dorsal spines. The segments of the proximal pinnules have slightly projecting and spinous distal ends. It is possible that the specimens from the Aru Islands described by Reichensperger under the name of *Amphimetra variipinna* (see page 281) should be referred to this form, as well as the specimen he described under the name of *Craspedometra anceps* (*C. aruensis*, n. sp.?).

Remarks.—This species appears to be most closely related to *H. crenulata*, but it differs in its cirri, which are more slender, especially distally, with rudimentary dorsal spines and longer terminal segments, the total number of the segments being less; in its lower pinnules, which are not nearly so much enlarged and of which the component segments have less produced distal edges; and in its general build, which is considerably more slender. The general ruggedness so very characteristic of *H. crenulata* is quite absent in this species, and the overlapping of the brachials is much less marked.

Localities.—Singapore; Svend Gad [A. H. Clark, 1908, 1909 1918] (1, C. M.).

Fadiffolu, Maldive archipelago; J. Stanley Gardiner [A. H. Clark, 1912, 1913] (1, B. M.).

History.—This species was described in 1908 under the name of *Himerometra producta* from a single specimen from Singapore. On the establishment of the new genus *Amphimetra* in 1909, *producta* was assigned to it. Later in 1909 the features distinguishing it from *H. crenulata* were given in detail. In 1912 it was compared with *H. propinqua* (see below), and in another paper with the type specimen of *H. variipinna* (see p. 278). In 1913 it was recorded, as *Amphimetra producta*, from the Maldive Islands on the basis of a specimen in the British Museum that had been labeled ?*Antedon laevissima* by Prof. F. Jeffrey Bell. In the report on the unstalked crinoids of the *Siboga* expedition published in 1918 *producta* was transferred to the genus *Heterometra*.

HETEROMETRA PROPINQUA (A. H. Clark)

PLATE 25, FIGURES 97–100

Amphimetra propinqua A. H. CLARK, Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 31 (description; *Siboga* station 318).

Heterometra propinqua A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. VIII (discovery by the *Siboga* and its significance), p. 76 (in key; range), p. 80 (detailed description; stations, 318, 320), p. 276 (listed), pl. 18, figs. 33, 34.—GISLÉN, Kungl. Fysiogr. Sällks. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnostic features.—This species very closely resembles *H. producta*, but the cirri are slender and tapering with all the component segments approximately subequal in length, about twice as long as broad at the ends. The cirri have 24–36 (usually 30–33) segments. The 10–13 arms are 90–120 mm. long.

Description.—The cirri are VIII–XIII, 24–36 (usually 30–33), 26 to 32 mm. (usually about 30 mm.) long, very slender, tapering gradually to the end of the proximal third and being especially slender from that point onward, recalling the cirri of *Leptometra celtica.* All the cirrus segments are approximately subequal in length, about twice as long as broad at the ends, though those in the distal third of the cirri are slightly carinate, which makes them appear slightly shorter, and those in the proximal half are slightly longer with slightly expanded ends. On the outermost segments there is a slight indication of dorsal tubercles.

The 10 to 13 (usually 11–13) arms are 90–120 mm. long.

P_1 is 7.5 mm. long, with 18 segments, which, gradually increasing in length, become about as long as broad on the fourth or fifth and twice as long as broad terminally; the second-eighth have a strong, though rounded, supplementary ridge. P_2 is 10.5 mm. long, with 17 segments, slightly stouter basally than P_1, tapering less gradually and composed of longer segments; there is a supplementary ridge on the second-ninth segments. P_3 is similar to P_2, 9 mm. long. P_4 is 6 mm. long, with 11 segments and has a supplementary ridge on the second-fourth or -fifth. P_2 and P_3 are not stouter basally than the succeeding pinnules, but they taper with slightly less rapidity; the distal angles of their component segments are only slightly swollen and produced. The distal pinnules are 10 mm. long and are composed of 20 segments.

The color in alcohol is brownish white with occasional narrow bands of rusty on the arms; the cirri are white.

Notes.—The characters of the six specimens from *Siboga* station 318 are included in the preceding description.

One of the specimens from *Siboga* station 320 has 11 arms 120 mm. long with a single IIBr 4(3+4) series; the cirri are 30 mm. long and are composed of 33 segments. The other is smaller with 12 arms about 55 mm. long, both the IIBr series being 2, and the cirri 20 mm. long.

Remarks.—This species is most closely related to *H. producta,* but it is even more slender and delicate. The elongate distal cirrus segments serve to distinguish it at once.

Localities.—*Siboga* station 318; south of eastern Borneo (lat. 6°36′30″ S., long. 114°55′30″ E.); 88 meters; fine yellowish gray mud; February 22, 1900 [A. H. Clark, 1912, 1918] (6, U.S.N.M., E. 431; Amsterdam Mus.).

Siboga station 320; south of eastern Borneo (lat. 6°05′00″ S., long. 114°07′00″ E.); 82 meters; fine yellowish gray mud; February 22, 1900 [A. H. Clark, 1918] (2, U.S.N.M., E. 420; Amsterdam Mus.).

History.—This species was first described in 1912 from specimens from *Siboga* station 318. In 1918 it was redescribed and figured, and specimens were recorded also from *Siboga* station 320.

HETEROMETRA VARIIPINNA (P. H. Carpenter)

PLATE 26, FIGURES 104, 105

Antedon variipinna P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 506 (description; Canton, China); Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger*

Reports, vol. 26, Zoology, 1888, p. 256 (specimen from Canton; the description and other records refer to *H. crenulata*).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 17 (characters; based chiefly upon *A. crenulata*).

Antedon brockii Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 183 (description; Amboina); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 11 (collected by Brock at Amboina), p. 18 (in key), p. 23 (detailed description and comparisons), p. 113 (in Göttingen Mus.), pl. 1, figs. 4,, 12, 13, pl. 2, fig. 17.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 16 (synonym of *Antedon variipinna* P. H. Carpenter, 1882); Crinoids of the Indian Ocean, 1912, p. 36 (=*Heterometra brockii*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76, footnote 2 (=*Heterometra variipinna*).

Himerometra brockii A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra variipinna (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Amphimetra variipinna A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed [the species contemplated is *H. crenulata*]); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 16 (type specimen redescribed; includes *Antedon brockii;* not *variipinna* of authors, which is covered by the name *crenulata*); Crinoids of the Indian Ocean, 1912, p. 110 (in part; record from Canton; other records refer to *H. crenulata*); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 314 (Australian records all refer to *H. crenulata*); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range in east Asia).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 92 (Aru Islands; details of localities and notes).—A. H. Clark, Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (Malayan species; range and its significance); Mortensen, Hong Kong Nat., Suppl. No. 3, 1934, p. 5 (Canton).

Heterometra brockii A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 11 (listed); Crinoids of the Indian Ocean, 1912, p. 36 (identity), p. 127 (synonymy; Amboina).

Heterometra variipinna A. H. Clark, Unstalked crinoids of the *Siboga*-Exped. 1918, p. 76 (in key; range; synonymy).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh. vol. 7, No. 1, 1936, p. 10 (relation to *H. crenulata*).

Antedon brocki Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 23 (synonym of *variipinna*).

Diagnostic features.—The enlarged lower pinnules are stout and are composed of cylindrical segments of which the distal ends are everted and finely spinous; in fully developed specimens P_2 is the longest pinnule and is composed of 22–35 segments.

The cirri are 17–30 mm. long and composed of 28–38 segments of which a few are about as long as broad or slightly longer than broad, and the outer are about one-third again as broad as long; long and sharp dorsal spines are developed from the ninth-twelfth onward. The 20–28 arms are 50–140 mm. long. The disk is more or less extensively plated, especially on and about the anal tube.

Description.—According to Carpenter the centrodorsal is a moderately thick convex disk with the cirri in a double row.

The cirri are about XXV, about 30. The segments are tolerably uniform, the fifth being about as long as broad, the next two or three a trifle longer than broad, and those following shorter again. From about the twelfth onward the segments have rather sharp dorsal spines, that on the penultimate (the opposing spine) being considerably larger than its predecessors.

The radials are partially visible. The IBr$_1$ are oblong, short and broad, partially united laterally. The IBr$_2$ (axillaries) are also short, but little longer than the IBr$_1$, and pentagonal with very open angles. The IIBr series are 4(3+4), the elements having somewhat uneven edges. The IIIBr series are 2.

There are 23 arms probably about 50 mm. long. The first segments after each axillary are rhomboidal and are closely united laterally. The second brachials are bluntly wedge-shaped. The first syzygial pair (composed of brachials 3+4), and the four next brachials are short and oblong. The following brachials are short, bluntly wedge-shaped, and overlap rather strongly so as to give the arms a serrate appearance; the brachials become more oblong again at about the middle of the arm.

Syzygies occur between brachials 3+4, again from between brachials 20+21 to between brachials 26+27, and distally at intervals of 8–13 (usually 10 or 11) muscular articulations.

The size of the lower pinnules varies considerably according as they are on the outer or inner arms of the postradial series. P_D is moderately long and stout at the base but tapers rather rapidly. P_1 on the outer arms is both longer and stouter than P_D, sometimes very much so, while P_2 is equal to, or slightly longer than, P_1. P_a and P_b are both smaller than the corresponding pinnules on the outside of the arm, and the size decreases to P_4 and P_d, after which it gradually increases again. On the inner arms of the postradial series the fifth brachial usually bears the largest pinnule, those on the second and seventh brachials being about equal. The distal ends of the cylindrical segments of the large proximal pinnules are raised into slight spines.

The disk is naked and considerably incised; it is 10 mm. in diameter. Sacculi are closely set along the pinnule ambulacra.

The color is purple with whitish bands.

Notes.—My notes on Carpenter's type specimen, which I examined at the Hamburg Museum in 1910, are as follows: The centrodorsal is moderate in size with a slightly convex dorsal pole 2 mm. in diameter. The cirri are about XX, 28–33, from 17 to 20 mm. in length. The longer proximal segments are about as long as the distal width, sometimes very slightly longer. The outer segments are about one-third again as broad as long. The earlier segments have slightly thickened and prominent distal dorsal edges. The ninth-twelfth (usually the latter) and following develop long and sharp dorsal spines. Of the 10 IIBr series 7 are 4(3+4) and 3 are 2. There are present 3 IIIBr 2 series, all internally developed. The 23 arms were probably about 50 mm. long. The longest pinnules have about 22 segments. The distal edges of the third and following segments of the proximal pinnules are strongly everted and very finely spinous instead of being with broad lateral processes as in *H. crenulata*. The disk is completely covered with a pavement of small irregular plates.

The type specimen of *Antedon brockii* from Amboina was described by Hartlaub in the following terms: The centrodorsal is rather large and thick with a bare flat dorsal pole. The cirri are arranged in two and a partial third marginal rows. Cirri about XXX, 30–37, reaching 30 mm. in length, stout, and not entirely confined to the border of the centrodorsal. Some of the cirrus segments may be a little longer than broad. Strong dorsal spines are developed from the tenth or twelfth segments onward. The radials are only very slightly visible. The IBr_1 are short, partially united laterally. The IBr_2 (axillaries) are short and pentagonal. The IIBr series are 4(3+4). The IIIBr series are 2, developed only internally. Feeble synarthrial tubercles are developed, the best developed being between the first two brachials. The 28 arms are about 140 mm. long and composed of short brachials of which the first 9 or 10 have smooth articulations and are longer than those following. The first syzygial pair (composed of brachials 3+4) is about as long as broad. The few immediately following are discoidal and form with each other feeble alternating elevations and depressions, rendering the surface of the arm as a whole somewhat uneven. There then follows a row of somewhat wedge-shaped brachials, which soon pass over into discoidal brachials. The brachials remain short to the arm tips. Because of the produced distal ends of the brachials the dorsal profile of the arms is gently serrate. Syzygies occur between brachials 3+4, again from between brachials 23+24 to between brachials 27+28, and distally at intervals of from 8 to 10 muscular articulations. P_D, and P_1 on arms arising from a IBr axillary, is slender and about 11 mm. long. P_1 on other arms is almost as long but not quite so stout as P_2, which reaches 20 mm. and is composed of about 30–35 segments. P_3 is markedly shorter, and the length of the two following decreases. P_a varies in size but is mostly as long as P_D. Sometimes it is almost as long as P_b, which is always a good deal shorter than the long, slender P_2, which becomes very slender in its outer portion. The distal pinnules reach 12 mm. in length. All the lower pinnules are remarkable for the somewhat produced finely toothed distal edges of their segments. The disk is 15 mm. in diameter and strongly incised. The disk bears conspicuous small conical lateral papillae opposite the first forking of the ambulacral grooves. The anal tube is plated. The color is deep blackish brown with a reddish cast.

From Dr. Merton's station 10 Reichensperger recorded 18 specimens with 11–20 arms from 50 to 80 mm. long. The cirri are XV–XXIV, 35–38, up to 23 mm. in length. From about the tenth onward the segments are provided with prominent sharp dorsal spines. The radials and the IBr$_1$ are easily visible. Synarthrial tubercles are developed on the articulation between the elements of the IBr series. The IIBr series are almost without exception 4(3+4); but in one 20-armed specimen there are exceptionally two IIBr 2 series. There are no division series beyond the IIBr series. The distal brachials are exceedingly short, sometimes almost triangular. Syzygies occur between brachials 3+4, from between brachials 13+14 to between brachials 17+18, and distally at intervals of 11–15 muscular articulations. P_3 is the longest pinnule and is composed of 11 or 12 segments, which are longer than broad and bear rounded and mostly finely dentate processes on the distal edge. Similar processes are borne by the pinnules of the fifth, sixth, and seventh brachials. The color is variegated, broadly banded with light to dark violet and brick red; the cirri are mostly dark violet.

In another lot from Merton's station 10 there are eight specimens representing two color varieties. Two specimens are grayish white with the cirri and ambulacral grooves mostly dark violet. Six specimens are wholly brick-red. There are 12–18 arms which in the largest are 90 mm. long. All the IIBr series examined by Reichensperger are 4(3+4).

The third lot from Merton's station 10 consisted of three large specimens that had been fixed in corrosive sublimate and had been red when alive; three red and violet examples; and 10 calices from animals which in life were cross banded red brown and white, the disk with triangular white patches situated singly between the ambulacral grooves.

From Dr. Merton's station 13 there were four specimens of which one had the arms 45 mm. long, and the smallest had 11 arms only 30 mm. long, the single IIBr series being 4(3+4). The two other specimens had 11 and 14 arms up to 90 mm. in length. The color was dark violet and white, variously divided.

From between Batu Kapal and Meriri there were two specimens each with 11 arms, which in one were 90 mm. and in the other 50 mm. long. The larger specimen, in addition to XI normal cirri, possesses a large number of very small flagellate tapering cirri—cirri in process of regeneration.

From Dr. Merton's station XII there are three specimens, two with 13 and one with 16 arms, the arm length being up to 70 mm. The color is the same as in those first described from station 10.

From Dr. Merton's station 17 there is a strikingly slender regular 10-armed specimen with the arms 70 mm. long. The cirri are very short and compressed, as in the others, up to 7 mm. long with 16–18 segments most of which from the base outward are feebly spined. The synarthrial tubercles are scarcely marked, and the distal brachials in comparison with the other specimens are broader and less triangular. The color in life was banded dark violet-brown and yellow.

Remarks.—I am not quite sure that Reichensperger's specimens from the Aru Islands really belong to this species. The description of P_3 certainly agrees much more closely with P_3 in *H. producta* than with P_3 in *H. variipinna*, while the number of arms and the size also suggest that species.

Localities.—Canton, China; Werner [P. H. Carpenter, 1882, 1883, 1888; A. H. Clark, 1907, 1912, 1918; Th. Mortensen, 1934] (1, H. M.).

Amboina; Dr. J. Brock [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1912, 1918].

Aru Islands; Dr. H. Merton's station 10; north of Penambulai; 8 meters; stony bottom; April 2, 1908 [Reichensperger, 1913].

Aru Islands; Dr. H. Merton's station 13; Sungi Barkai (eastern half); 15 meters; rocky bottom; April 9, 1908 [Reichensperger, 1913].

Aru Islands; between Batu and Meriri; 10 meters; March 30, 1908 [Reichensperger, 1913].

Aru Islands; Dr. H. Merton's station XII; off Mimien; 15 meters; coarse sand; April 8, 1908 [Reichensperger, 1913].

Aru Islands; Dr. H. Merton's station 17; Sungi Manumbai (Kapala Sungi); 20 meters; rocky bottom; May 5, 1908 [Reichensperger, 1913].

Geographical range.—Known from Amboina and the Aru Islands. The record from Canton needs confirmation as Canton is more or less of a center for "curios" gathered over a wide area.

Bathymetrical range.—From the shoreline down to 20 meters. The average of 6 records is 11 meters.

Remarks.—Hartlaub said that at first sight *Antedon brockii* resembles *Antedon ludovici* (that is, *Heterometra amboinae*) in its black color, its centrodorsal, its cirri, and the form of the brachials. But a comparison of the pinnules serves immediately to differentiate the two species, for the carination so characteristic of the proximal pinnules in *H. amboinae* is entirely lacking in *Antedon brockii*. He noted that the small conical protuberances on the disk may represent the soft parts of the lowest pinnules, which have become detached from the pinnules and developed independently. Similar protuberances are found to be strongly marked in the type specimen of Lovén's *Hyponome sarsii* (=*Zygometra microdiscus*) in the Hamburg Museum and also on the figures of *Ant. multiradiata* Lam. (in reality of P. H. Carpenter) (=*Zygometra microdiscus*) given in the *Challenger* report on the stalked crinoids, volume 11, part 32, 1884, plate 55, figures 3, 4.

The type specimen of *variipinna* from Canton represents a species related to *H. producta* from which it differs in having long spines on the outer cirrus segments instead of a slight carination. It is also a stouter form than *producta*, the cirri especially being stouter and longer without the distal taper seen in those of *producta*. The lower pinnules are more cylindrical—less prismatic—than are those of *producta*, and the spinous eversion of the distal ends of the segments is not increased at the prismatic angles, but is uniform all around the dorsal side.

So far as I can see the type specimen of *Antedon variipinna* P. H. Carpenter differs from the type specimen of *Antedon brockii* Hartlaub only in its smaller size. In both specimens the disk is plated, which is most unusual in the genus *Heterometra*.

History.—This species was first described by Dr. P. H. Carpenter in 1882 from a specimen labeled Canton, China, in the Hamburg Museum under the name of *Antedon variipinna*. He gave a specific formula for the species in the succeeding year.

In the *Challenger* report on the comatulids published in 1888 Carpenter placed in the synonymy of *Antedon variipinna* his *Antedon crenulata* described at the same time, and Bell's *Antedon decipiens* and *A. irregularis* described in 1884. These last three —*crenulata, decipiens*, and *irregularis*—really represent a quite different species with sharply prismatic proximal pinnules bearing conspicuous processes on the distal ends of the prismatic ridges of their component segments. The manuscript names *Comatula dubia, Antedon dubia*, and *Antedon bidentata* published by von Graff also apply to this latter species. Subsequent authors have accepted Carpenter's interpretation of these forms and have without exception used the name *variipinna* for the species herein called *H. crenulata*.

In 1890 Dr. Clemens Hartlaub described *Antedon brockii* from a specimen collected by Dr. J. Brock at Amboina in 1884–85, redescribing and figuring it in 1891.

In 1910 I examined the type specimen of Carpenter's *Antedon variipinna* at Hamburg and was surprised to find that it was quite a different thing from the species that I, following Carpenter's *Challenger* report, had been accustomed to consider as *variipinna*.

Carpenter had said in his original description that the distal ends of the cylindrical segments of the large proximal pinnules are raised into slight spines, and this was found to be the case. The lower pinnules are very different from those of the other forms which had been considered as synonyms of *variipinna*. On the other hand, no characters could be found whereby Carpenter's *variipinna*, as represented by the type specimen, could be distinguished from Hartlaub's *brockii*. So in the author's paper on the crinoids in the Hamburg Museum published in 1912 *brockii* was placed in the synonymy of *variipinna*, and from this synonymy all the various forms previously included were removed.

In 1913 Dr. August Reichensperger recorded and gave notes upon numerous specimens of this species which had been collected by Dr. H. Merton in the Aru Islands in 1908.

In a memoir on the echinoderms of Hongkong published in 1934 Dr. Th. Mortensen listed *Amphimetra variipinna* with the locality, Canton, given by Carpenter.

HETEROMETRA ASTYANAX, sp. nov.

PLATE 34, FIGURES 152–156

Diagnostic features.—The cirri taper conspicuously distally so that the terminal third or fourth is only about half as broad in lateral view as the proximal portion; the cirri are almost smooth, the last 10–15 segments bearing only slight and inconspicuous dorsal tubercles; the distal cirrus segments are always longer than broad, varying from slightly longer than broad to twice as long as broad; and the cirri are long, reaching rather more than one-fourth the arm length.

The cirri are 30–33 mm. long, with 37–39 segments. The 19 arms are 120 mm. long.

Description.—The centrodorsal is discoidal, rather thin, with the broad dorsal pole, which is 5 mm. in diameter, almost flat. The cirri are arranged in a single slightly irregular marginal row.

The cirri are XXVII, 37–39, from 30 to 33 mm. long; they are moderately stout at the base and taper slowly distally so that the terminal third or fourth is only about half as broad in lateral view as the proximal portion. The first segment is about twice as broad as long, and those following slowly increase in length, becoming about as long as broad on the twelfth and from half again to twice as long as broad on the last three or four, on which the cirrus usually tapers with increased rapidity; in some cases these last segments taper more slowly, and they may be scarcely longer than broad. The last 10 to 15 segments bear a subterminal dorsal tubercle, which is scarcely perceptible except on the last five or six. The opposing spine is well developed, slender, and directed obliquely forward. The terminal claw is nearly half again as long as the penultimate segment and is slender and moderately curved.

The radials are entirely concealed. The IBr_1 are concealed in the median line but are visible as long narrow triangles extending inward so that their apices are more or less near the midradial line. The IBr_2 (axillaries) are low triangular, three to four times as broad as long, with the lateral angles truncated and thus forming short straight sides which are somewhat more than half as long as the narrow lateral bases of the triangles representing the IBr_1. The elements of the IBr series and the first two brachials are in close lateral contact and are sharply flattened laterally. The IIBr series are 4(3+4) and the IIIBr series are 2; there are in the type specimen five IIBr and four IIIBr series, making 19 arms in all. The 19 arms are 120 mm. long. The brachials beyond the proximal quarter of the arms are exceedingly short and almost oblong, as in the species of *Himerometra.*

P_1 is 11–13 mm. long and composed of 17–20 segments. The pinnule is rather stout proximally but tapers rapidly at the end of the proximal half and is flagellate in the distal half. A rather prominent ridge runs the entire length of the pinnule on the outer side, and the second-seventh or -eighth segments are provided with strong carinate processes having the distal edge straight and parallel to the axis of the pinnule, which make the pinnule appear disproportionately broad basally. The earlier segments are much broader than long, those succeeding becoming about as long as broad on the ninth or tenth and half again as long as broad terminally. P_2 is 16 mm. long, with 26 segments, of which the earlier are about twice as broad as long, those following becoming as long as broad on the eleventh or twelfth, and one-third again as long as broad terminally. The pinnule is about as stout basally as P_1, but it tapers very gradually and regularly distally and hence appears much stouter. A ridge runs the entire length of the outer side of the pinnule and the first 10 segments bear prominent carinate processes which from the seventh outward decrease slowly in height. P_3 is 19 mm. long, with 27 segments. It resembles P_2 and is of about the same width basally, but it tapers less rapidly, especially in the distal half, so that it appears stouter. The carinate processes on the earlier segments are slightly smaller than those on P_2. P_4 is 13 mm. long, with 25 segments. It is slightly less stout basally than P_3 and tapers gradually, becoming very slender in the terminal third. The earlier segments are about twice as broad as long, those following becoming about as long as broad on the eleventh and twice as long as broad terminally. As in P_2 the lateral ridge is conspicuous and is more or less tuberculated. The second-seventh segments bear narrow, though very prominent, carinate processes. P_5 is 10 mm. long, with 22 segments, and is much smaller and more slender than the preceding pinnules. The carinate processes on the second-seventh segments are rather more conspicuous than they are on the preceding pinnules, causing the pinnule to appear rather disproportionately broad in the basal half. The succeeding pinnules are similar, the next three or four slowly decreasing in size.

Locality.—Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 66; off western Java (lat. 5°54′ S., long. 106°12′ E.); 24 meters; sand and shells; July 27, 1922 (1, C. M.).

Remarks.—This species seems to approach *Craspedometra* in the marked terminal taper of the cirri. It is almost intermediate between *Craspedometra acuticirra* and such species of *Heterometra* as *H. amboinae.*

HETEROMETRA AFFINIS (Hartlaub)

Antedon affinis Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 184 (description; Amboina); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 11 (collected by Brock at Amboina), p. 18 (in key), p. 25 (detailed description and comparisons; Amboina), p. 113 (in Göttingen Mus.), pl. 1, fig. 14, pl. 2, figs. 18, 24.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 37 (identity).

Himerometra affinis A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Heterometra affinis A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 11 (listed); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 127 (synonymy; habitat); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 79 (in key; range), p. 82 (station 99; notes), p. 272 (listed).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnostic features.—The enlarged proximal pinnules are smooth with the earlier segments carinate, and P_2 is the largest and longest. The longest cirri have not more than 30 segments of which a few are slightly longer than broad and the outermost bear small dorsal spines. The 15–18 arms are 65–120 mm. long and are composed of wedge-shaped brachials.

Description.—The centrodorsal is a rather small disk with the cirri arranged in two irregular rows. The cirri are not confined to the margin but leave only a rather small irregular central portion of the dorsal surface bare.

The cirri are about XXIV, 20–30, the longest 20 mm. long. A few of the segments are slightly longer than broad. The distal segments are strongly compressed laterally and keeled; they strongly overlap the bases of the succeeding segments so that here the dorsal profile of the cirri appears serrate; the outermost segments have small dorsal spines.

The radials are only partially visible. The IBr_1 are partially united laterally. The IBr_2 (axillaries) are rather short and pentagonal. One of the IBr series bears two undivided arms. The four others bear on one side an undivided arm and on the other a IIBr 4(3+4) series. Each IIBr series bears a single IIIBr 2 series. The first elements of the IIBr series are short and of the same length as the first brachials of the adjacent arms with which they are laterally united.

The 18 slender and rather smooth arms are apparently about 65 mm. long. The basal brachials are short, the first being shorter than the second. The first syzygial pair (composed of brachials 3+4) is also short. The following brachials are short disks with feebly produced ends. From the eighth or ninth brachial onward there is a series of brachials that are triangular and a good deal larger; about the thirtieth the brachials become shorter and blunter, wedge-shaped, farther on short discoidal, and finally more squarish.

Syzygies occur between brachials 3+4, again from between brachials 11+12 to between brachials 14+15, and distally at intervals of from 9 to 11 muscular articulations. The second syzygy in arms which arise from the IBr axillaries is between brachials 8+9 or 9+10, and the intersyzygial interval beyond is 5 or 6 muscular articulations.

The lowest pinnules, whether on the IIBr series or on the arms, are very small and delicate with carinate and rather large basal segments. P_1 when following a pinnule on a IIBr series is a good deal larger than these and measures about 9 mm. in length. P_a is very small. The largest pinnule is P_2, which measures 12 mm. The pinnules following decrease in length to P_6. The pinnule of the sixth brachial (P_b) is smaller than that of the fifth (P_2). The pinnule of the seventh brachial (P_3) on arms arising directly from a IBr axillary is almost as long as that of the fifth (P_2). The pinnules of about the first 20 brachials have a few carinate basal segments. The length of the succeeding pinnules reaches 7 mm.

The disk is 13 mm. in diameter, and is naked and incised. Sacculi are very numerous on the arms and pinnules.

The color is light chocolate-brown, with the disk dark brown.

The preceding description is adapted from Hartlaub's description of the type specimen.

Notes.—One of the specimens from off Jolo has 18 arms about 120 mm. long. The other is very small with 11 arms, one IIBr 4(3+4) series being developed.

The specimen from *Siboga* station 99 has 15 arms about 70 mm. long; each IBr series bears on the right hand side (as viewed dorsally) a IIBr 4(3+4) series; the two additional arms on the left anterior ray are as yet only 22 mm. in length, measured from the axillary. The longest cirrus has 29 segments. This appears to be a young individual just completing the adolescent autotomy.

Of the specimens from Singapore one has 16 arms 50 mm. long and another has 15 arms 55 mm. long.

Localities.—Dr. Th. Mortensen's Pacific Expedition 1914–'16; off Jolo, Philippines; about 36–55 meters; sand and coral; March 19, 1914 (2).

Siboga station 99; anchorage off North Ubian, southern part of the Jolo (Sulu) Archipelago (lat. 6°07′30″ N., long. 120°26′00″ E.); 16–23 meters; lithothamnion bottom; July 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Singapore; shallow water; Mr. Svend Gad (3, U. S. N. M., E. 1082; C. M.).

Amboina; Dr. J. Brock [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1912].

Geographical range.—From the Philippines to Singapore and southward to Amboina.

Bathymetrical range.—From the shoreline down to 36 (?55) meters.

History.—This species was first described under the name of *Antedon affinis* by Dr. Clemens Hartlaub in 1890, and was redescribed and figured by him in the following year. He remarked that this new species shows much similarity to *Antedon bipartipinna* P. H. Carpenter and *A. ludovici* P. H. Carpenter—apparently representatives of the same species—which are also forms combining the presence of IIIBr series with slender carinate pinnules in the proximal arm region. As his specimen was not sexually mature Hartlaub said it was not impossible that the new species may prove to be simply a young stage of *Antedon ludovici*, although to him the characteristic features seem to point more to specific distinctness. He said that *Antedon affinis* differs from *A. ludovici* in its much smaller size and in its very slender build. In addition, its cirri have a relatively much finer structure and a smaller number of segments. Also, the synarthrial tubercles so characteristic of *A. ludovici* are lacking and the general surface of the first eight or nine brachials has only a suggestion of the unevenness which we find so marked in that species. Lastly the triangular brachials that follow the proximal brachials are markedly longer in *Antedon affinis* than the corresponding brachials in *A. ludovici*, which also are not triangular. The agreement between the two forms, according to Dr. Hartlaub, lies in the carination of the proximal pinnules and in the form of the proximal brachials, especially that of the first syzygial pair, and finally in the arrangement of the arms and the manner of the division of the postradial series.

In my first revision of the genus *Antedon* published in 1907 this species was assigned to the new genus *Himerometra*, and in the revision of the family Himerometridae published in 1909 it was assigned to the new genus *Heterometra*.

In 1918 a specimen from *Siboga* station 99 was recorded and notes on it were given.

HETEROMETRA PULCHRA A. H. Clark

PLATE 36, FIGURES 164, 165

Heterometra pulchra A. H. CLARK, Rec. Indian Mus., vol. 7, pt. 3, No. 26, July 1912, p. 269 (*nomen nudum;* Arrakan coast); Crinoids of the Indian Ocean, November 1912, p. 317 (detailed description; localities; comparisons); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78 (in key; range); Treubia, vol. 14, livr. 2, 1933, p. 208 (not included in *Siboga* collection), p. 212 (near Deli).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnostic features.—The brachials are distinctly wedge-shaped with the ends never quite parallel and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are 25–35 mm. long with 32–45 segments of which the longest are slightly longer than broad and the outer are slightly broader than long and bear rather small, though sharp and prominent, dorsal spines. The 24–32 arms are 85+ mm. long. P_3 is the largest and longest pinnule, 14–22 mm. long with 22–25 segments.

Description.—The centrodorsal is low hemispherical, with the bare dorsal pole slightly convex, finely pitted, 3.5 mm. in diameter. The cirrus sockets are arranged in 2 irregular rows.

The cirri are XX, 32–39 (usually nearer the latter), 25 mm. long. The longest cirrus segments are slightly longer than broad. The short distal segments are but little broader than long. Rather small, though sharp and prominent, dorsal spines are developed from the twentieth segment onward.

The radials are just visible beyond the rim of the centrodorsal. The IBr_1 are very short, bandlike, about six times as broad as long. The IBr_2 (axillaries) are nearly three times as broad as long, with the lateral edges slightly more than half as long as those of the IBr_1. Eight IIBr series are present in the type specimen, six of which are 4 (3+4) and two of which are 2. There are six IIIBr series, all 2, and all developed internally except one, which is developed externally by the side of an internal series. The division series are well rounded dorsally, in lateral apposition and laterally flattened as far as P_D, with the apposed edges slightly produced outward. The elements of the IIBr and IIIBr series are interiorly in lateral apposition through slightly produced edges.

There are in the type specimen 24 arms about 85 mm. long, perfectly smooth and well rounded dorsally.

P_D is 6 mm. long, with 22 short segments, none of which are longer than broad; the second-fifth are strongly carinate dorsally, and from the sixth segment onward the pinnule is rather strongly prismatic. P_1 is 12 mm. long, with 27 segments, all of which are short, the distal being scarcely twice as long as broad; the second-sixth are strongly carinate, and the pinnule is prismatic from the seventh onward. P_2 is 13 mm. long, with 25 segments, resembling P_1 but with the distal segments more elongate; the second-sixth segments are carinate. P_3 is the largest and longest pinnule, 14 mm. in length, slightly stouter throughout than P_2, with 22 segments, of which the second-seventh are carinate; a supplementary carination extends along the pinnule from the sixth segment to the tip. P_4 is 9 mm. long, with 18 segments. P_5 is 6 mm. long. The carination of the earlier segments is very strong on the fifth-seventh pinnules but nearly or quite obsolete from that point onward.

The color in alcohol is flesh color, with purple bands at the articulations. The cirri are yellow.

Notes.—In the specimen from off Jolo the cirri are 35 mm. long and are composed of 39–45 segments. There are 32 arms. All the IIBr series are 4 (3+4), and all the following division series are 2. P_3 is 22 mm. long and is composed of 24 or 25 segments.

This specimen seems to belong to *H. pulchra*, the slight differences presumably being due to greater size as compared with the type.

Remarks.—While in its general habitus this species perhaps most nearly resembles *H. savignii*, it is undoubtedly most closely related to *H. singularis*, from which it differs most strikingly in having P_3 instead of P_2 the largest pinnule.

Localities.—*Investigator* station 387; southwest of the mouths of the Irrawaddy river, off Cape Negrais, Burma (lat. 15° 25′ N., long. 93° 45′ E.); 73–89 meters; sand and coral; November 16, 1909 [A. H. Clark, 1912] (1, I. M.).

Investigator; Arrakan coast, Burma [A. H. Clark, 1912] (3, U.S.N.M., 35077, 35194, 35212).

Near Deli, northern Sumatra (lat. 3° 40′ N., long. 99° 10′ E.); 16–18 meters; June 25, 1908 [A. H. Clark, 1933] (2, Buitenzorg Mus.).

Dr. Th. Mortensen's Pacific expedition, 1914–16; off Jolo, Philippines; about 27 meters; March 21, 1914 (1, C. M.).

Geographical range.—From the Philippines to the coast of Burma.

Bathymetrical range.—From 27 to 73 (?89) meters.

History.—This species was first mentioned in July 1912, when two small and broken specimens were recorded from the Arrakan coast of Burma. It was formally described in November of the same year from a single specimen dredged by the *Investigator* at station 387.

In 1933 I recorded two additional specimens in the Buitenzorg Museum from near Deli, Sumatra.

HETEROMETRA GRAVIERI A. H. Clark

Heterometra gravieri A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 8 (southeastern Africa), p. 25 (description; Zanzibar); Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 251 (detailed description; Zanzibar); Crinoids of the Indian Ocean, 1912, p. 127 (synonymy; habitat); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78 (in key; range).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 48.—A. H. CLARK, John Murray Exped. 1933-34, Sci. Reports, vol. 4, No. 4, 1936, p. 100 (range), p. 104.

Diagnostic features.—The brachials are distinctly wedge-shaped with the ends never quite parallel and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are 21 mm. long with 36–39 segments of which the longest are from one-third to one-half again as long as broad and those in the distal half are about twice as broad as long and bear short dorsal spines. The 19 arms are 80 mm. long. P_2 is the longest pinnule and is composed of 24 segments. P_3 is slightly smaller than P_2, but much larger than P_1. P_4 is about as large as P_1.

Description.—The cirri are XXVIII, 36–39, 21 mm. long, more slender than those of *H. joubini.* The first segment is short and the following gradually increase in length to the fifth or sixth, which is from one-third to one-half again as long as broad, and after the eighth or ninth begin to decrease again so that those in the distal half of the cirri are about twice as broad as long. The segments in the outer half of the cirri bear short dorsal spines.

Nine IIBr series of 4(3+4) are present. The division series have produced lateral borders.

The 19 arms in the type specimen are 80 mm. long. The brachials are only very slightly overlapping. The arm structure resembles that of *H. joubini.*

P_1 is small and weak. P_2 is half again as long as P_1, slender, and flagellate distally, with 24 segments of which the second-fifth are carinate. P_3 is slightly smaller than P_2 but much larger than P_1. P_4 is about as large as P_1. The following pinnules are slightly shorter than P_4. The basal segments of all the lower pinnules are distinctly carinate.

Remarks.—Though of the same size as *H. joubini*, this species is as a whole more slender and delicate.

Locality.—Zanzibar; M. Rousseau, 1841 [A. H. Clark, 1911, 1912, 1918] (1, P. M.).

History.—Dr. P. H. Carpenter examined this specimen in the Paris Museum, placing with it a label indicating that it was an undescribed form differing from *H. joubini* (see p. 312). It was described in 1911 both in a paper on the recent crinoids in the Paris Museum and in a memoir on the crinoids of the coasts of Africa.

HETEROMETRA SINGULARIS A. H. Clark

PLATE 36, FIGURES 161–163

[See also vol. 1, pt. 2, fig. 269 (arm and pinnules), p. 207; figs. 455, 456 (pinnule tip), p. 261.]

Heterometra singularis A. H. CLARK, Proc. U. S. Nat. Mus., vol. 36, 1909, p. 638 (description; southern portion of Malacca Strait); Vid. Medd. Nat. Foren. København, 1909, p. 164 (Singapore; description of a specimen), p. 193 (collected at Singapore by Svend Gad); Crinoids of the Indian Ocean, 1912, p. 128 (synonymy; detailed description; localities), fig. 11, p. 129; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78 (in key; range); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 638 (80 miles northwest of Penang; notes); Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 556 (*Investigator* station 548, 549; notes).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnostic features—The brachials are distinctly wedge-shaped with the ends never quite parallel and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are about 35 mm. long with 36–39 segments of which the longest are about as long as broad and the outer are slightly broader than long and bear conspicuous dorsal spines. The 12–20 arms are 90–150 mm. long. P_2 is the largest pinnule, P_3 being of the same length as P_1.

Description.—The centrodorsal is discoidal, the bare polar area flat, 1.5 mm. in diameter. The cirrus sockets are arranged in a single crowded, more or less irregular, marginal row.

The cirri are XVII, 21–25, 12 mm. long. The first segment is short, the second is about twice as broad as long, the third is somewhat longer, and the fourth is about as long as broad. The next two are slightly longer than broad, and those following gradually decrease in length so that the terminal 15 are one-third to one-half again as broad as long. On the seventh subterminal dorsal spines begin to develop and soon become long and prominent. The opposing spine is large and long, much larger than the spines on the preceding segments, triangular, the apex terminal, arising from the whole surface of the penultimate segment and about equal to the width of that segment in height. The terminal claw is nearly twice as long as the penultimate segment, slender, abruptly curved proximally, becoming nearly straight distally.

The radials are short, oblong, the dorsal surface with numerous prominent rounded tubercles. The IBr_1 are short, oblong, slightly over four times as broad as long, in close lateral apposition. The IBr_2 (axillaries) are broadly pentagonal, almost triangular, twice as broad as long, the lateral edges shorter than those of the IBr_1. The IIBr are 4(3+4); the ossicles up to and including the second brachial exteriorly and the fourth interiorly, as well as the first two segments of the first three pinnules, are in close apposition and sharply flattened, the lateral edges somewhat produced.

The 11 arms are 40 mm. long. The first two brachials are subequal, wedge-shaped, about twice as broad as the exterior length, the first interiorly united. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly, nearly three times as broad as the interior length. The next four brachials are oblong, nearly four times as broad as long, those following becoming almost triangular, about three times as broad as long, then gradually lengthening (though remaining almost triangular) to about twice as broad as long, and at a point somewhat beyond the proximal third of the arm rather quickly becoming wedge-shaped, almost oblong, about two and one-half times as broad as long. From about the ninth onward the brachials have prominent distal ends, though these do not overlap the bases of the succeeding segments.

Syzygies occur between brachials 3+4, 9+10, and 15+16 (the second sometimes omitted), and distally at intervals of 7–10 muscular articulations.

P_D is 4.5 mm. long, moderately stout basally but tapering rapidly in the proximal half and becoming slender distally, composed of 20 segments, which at first are about twice as broad as long, becoming about as long as broad after the eighth; the second-seventh segments are rather strongly carinate. P_1 is similar, very slightly longer and stouter. P_2 is 6 mm. long, considerably stouter and stiffer than the preceding and rather more strongly carinate basally, with about 20 segments of which the first 7 (except for the carinate process) are squarish and the remainder slightly longer than broad, becoming about half again as long as broad distally; the ridge in the distal half of the outer side is but little marked. P_3 is 3 mm. long, much smaller than any of the preceding pinnules, composed of about 12 segments, which at first are broader than long, becoming as long as broad at about the fifth and nearly twice as long as broad distally; the second-fifth segments are carinate. The following pinnules are similar and of about the same length, the segments becoming gradually longer and the basal carination gradually less. The distal pinnules are 5 mm. long. On the arms arising from a IBr axillary P_1, P_2, and P_3 are usually as described for P_D, P_1, and P_2; and P_4 is much smaller, as described for P_3; but occasionally P_2 is enlarged and similar to P_3 as described, instead of being small like P_1.

The disk bears a few calcareous granules in the anal area, especially on the anal tube.

Notes.—The specimens from *Investigator* station 549 have 15 and 27 arms.

The specimen from *Investigator* station 548 has 20 arms. Of the nine IIBr series present six are 4 (3+4) and three are 2. One IIIBr 2 series is present, developed internally on a IIBr 2 series. The cirri are XV, with several additional rudimentary, 41–44, up to 35 mm. in length.

One of the six specimens collected by the *Patrol* 80 miles northwest of Penang may be thus described. The centrodorsal is discoidal, moderately thick, with the bare dorsal pole flat, though with an irregular surface, 4 mm. in diameter. The cirrus sockets are arranged in two alternating marginal rows. The cirri are XXII, 37–39, about 35 mm. long. The first segment is short, and those following gradually increase in length to the fifth or seventh, which is about as long as broad. In the longest cirri the next 10 segments are subequal, somewhat longer than broad, and those succeeding slowly decrease in length so that the distal are broader than long, though never much so. On a segment somewhere between the fifteenth and the nineteenth a subterminal dorsal tubercle appears, which, two segments beyond, becomes a conspicuous dorsal spine and, in lateral view, appears as a narrow triangle with the sharp apex terminal, arising from the entire dorsal surface of the segment and in height equal to about one-third the width of the segment. The distal edge of the radials is just visible beyond the rim of the centrodorsal; it usually bears a single row of small and regular beadlike tubercles, but it may be simply roughened. The division series are broad, in close lateral contact, and laterally flattened. The lateral borders of the elements of the division series are slightly produced, the production forming a narrow margin with a straight outer edge. Of the eight IIBr series six are 4(3+4) and two are 2. The two IIIBr series, which are both developed on the same IBr series, are 2. The 20 arms are 150 mm. in length. The earlier brachials are wedge-shaped, short, twice as broad as the maximum length; beyond the proximal third of the arm the brachials become almost oblong and about four times as broad as the median length.

P_D is 10 mm. long and is composed of 32 segments. It tapers rapidly on the first nine segments, beyond which it is very slender. The first segment is much broader than long, but those succeeding gradually increase in length so that the eighth and following are about as long as they are broad. The first six segments are sharply carinate, the carination being narrow with the crest straight and parallel with the longitudinal axis of the segments. The first two or three segments are flattened against the corresponding segments of the adjacent pinnule on the neighboring arm. P_1 is about 13 mm. long and is composed of 34 segments. It tapers rather rapidly in the first eight segments, becoming slender and flagellate distally. The segments become as long as broad on the third to the sixth, then longer than broad, the last 10 being about twice as long as broad. The first seven segments are sharply carinate, the carination being highest on the second and third, and disappearing at the end of the seventh. P_2 is 19 mm. long and is composed of 33 segments, which become as long as broad on the fourth and on the last 10 are twice as long as broad. The second-seventh segments bear a sharp knifelike carinate process which is narrow with a straight crest parallel to the longitudinal axis of the segments. The pinnule is only moderately stout and tapers with extreme slowness from the base to the tip, which gives it a straplike appearance. P_3 is 13 mm. long, with 27 segments, which beyond the fifth are all about as long as broad. The second-sixth segments are sharply, though narrowly, carinate. P_4 is 9.5 mm. long, with 23 segments, less stout at the base than P_3 and tapering rather rapidly in the proximal half so that the distal half is slender and flagellate. The segments become as long as broad on the sixth and twice as long as broad terminally. The second-sixth segments are narrowly carinate.

Another specimen from 80 miles northwest of Penang resembling the preceding has 15 arms, there being four IIBr 4 (3+4) series and one IIIBr 2 series, the latter developed internally. The longest cirri have 36–39 segments.

A third specimen from the same locality has 12 arms 90 mm. long, there being present two IIBr 4 (3+4) series. The longest cirri have 32–33 segments.

The three other specimens from 80 miles northwest of Penang are more grayish in color and slightly smoother in appearance. One has 14 arms 140 mm. long; there are three IIBr 4 (3+4) series and a single IIIBr 2 series, the latter internally developed.

Another has 13 arms 130 mm. long; there are two IIBr 4 (3+4) series and one IIIBr 2 series, internally developed.

The last example has 13 arms 100 mm. long; there are two IIBr 4 (3+4) series and one internal IIIBr 2 series. The longest cirri have 41–43 segments and reach a length of 35 mm.

Although these six specimens are much larger and better developed than the type-specimen of *H. singularis,* there can be no doubt but that they represent that species.

The specimen from Singapore is in much better condition than the badly broken type specimen. It has 12 arms 65 mm. long, two IIBr 4 (3+4) series being developed on adjacent postradial series. The cirri are XV, 26–31, from 15 to 18 mm. long. This specimen was compared directly with the type and the only difference found was the slightly greater number of cirrus segments in the former. None of the cirri remaining in the type, however, appear to be quite mature.

Localities.—Investigator station 549; Mergui Archipelago, northwest of King Island (lat. 12°48′00″ N., long. 98°16′10″ E.); 44 meters; mud, sand, and shells; October 21, 1913 [A. H. Clark, 1932] (2, I. M.).

Investigator station 548; Mergui Archipelago, northwest of King Island (lat. 12°49′23″ N., long. 98°23′30″ E.); 42 meters; mud, sand, and shells; October 21, 1913 [A. H. Clark, 1932] (1, I. M.).

Eighty miles northwest of Penang; 73 meters; cable repair ship *Patrol,* Eastern and Associated Telegraph Co., through Colonel Grant, I. M. S.; taken in May, 1923, from a cable laid two years previously [A. H. Clark, 1929] (6, B. M.).

Investigator; southern portion of Malacca Strait [A. H. Clark, 1909, 1912] (1, I. M.).

Singapore; Svend Gad [A. H. Clark, 1909] (1, C. M.).

Geographical range.—From the Mergui Archipelago southward to the Malacca Strait, between the Malay Peninsula and Sumatra.

Bathymetrical range.—From the shoreline down to 73 meters.

History.—This species was first described in 1909 from a specimen obtained by the Royal Indian Marine Surveying steamer *Investigator* in the Malacca Strait. Another specimen collected at Singapore by the Danish consul, Svend Gad, was recorded in the same year. In 1912 the type specimen was redescribed and figured.

In 1929 six more specimens were recorded from 80 miles northwest of Penang, where they had been brought up by the cable repair ship *Patrol,* and in 1932 three more specimens were recorded that had been dredged by the *Investigator* in the Mergui Archipelago in 1913.

HETEROMETRA COMPTA A. H. Clark

PLATE 33, FIGURES 144–148

[See also vol. 1, pt. 2, fig. 268 (arm and pinnules), p. 207; figs. 453, 454 (pinnule tip), p. 261.]

Heterometra compta A. H. CLARK, Proc. U. S. Nat. Mus., vol. 36, 1909, p. 636 (description; Pedro Shoal); Crinoids of the Indian Ocean, 1912, p. 124 (synonymy; detailed description; Pedro Shoal), fig. 10, *a, b,* p. 126; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 79 (in key; range); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 15, fig. 51 (arm).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 23, 30.

Diagnostic features.—The brachials are distinctly wedge-shaped, with the ends never quite parallel, and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are 23–25 mm. long with 31–35 segments of which the longest are about as long as broad or slightly longer than broad, and the outer arc from half again to twice as broad as long and bear dorsal tubercles. The 16–25 arms are 125 mm. long. P_1 and P_2 are of the same length and similar with 26 segments and are much longer and slightly stouter than P_D. P_3 is scarcely longer than P_D.

Description.—The centrodorsal is discoidal, with the bare polar area flat, slightly convex or slightly concave, about 5 mm. in diameter. The cirrus sockets are arranged in a single more or less irregular marginal row.

The cirri are XVIII–XXIII, 31–35, from 23 to 25 mm. long. The first segment is very short, the next three are nearly two and one-half times as broad as long, and those following gradually increase in length to the sixth or seventh, which is about as long as broad. The next five to seven segments are usually slightly longer than broad, sometimes squarish, the following gradually decreasing in length so that the terminal fifteen or rather more are from half again to twice as broad as long. At about the fifteenth segment dorsal tubercles are developed, at first involving only the distal portion of the dorsal surface, later arising in a slightly convex line from near the proximal end, the apex being subterminal; these tubercles are narrow, laterally occupying only a small portion of the median part of each segment, and are slightly rounded dorsally. On the last three segments the tubercles become somewhat sharper, more erect, and move to a median position. The opposing spine is small, though larger than the tubercle on the preceding segment, blunt, arising from the entire dorsal surface of the segment, the apex median or sub-median in position, in height equal to about one-third the lateral width of the penultimate segment. The terminal claw is somewhat longer than the penultimate segment, rather stout and strongly curved.

There are no basal rays.

The radials are concealed by the centrodorsal. The IBr_1 are very short and band-like. The IBr_2 (axillaries) are short, almost triangular, two and one-half times as broad as long. The IIBr are 4 (3+4), in apposition laterally, though not laterally flattened; the $IIBr_1$ are entirely united interiorly. The IIIBr series are 2, rarely 4 (3+4). The IVBr series are 2, but are rarely present.

The 16–25 arms are 110 mm. long. The first two brachials are wedge-shaped, three times as broad as long exteriorly, the first interiorly united. The next four or five brachials are oblong, about four times as broad as long, and those following gradually becoming wedge-shaped, almost triangular, about three times as broad as long, and less oblique and somewhat longer in the outer portion of the arms. The distal portion of the arms is perfectly smooth dorsally.

Syzygies occur between brachials 3+4, again between brachials 13+14 to 20+21 (usually in the vicinity of the fifteenth) and distally at intervals of 7–11 (most commonly 8 or 9) muscular articulations.

P_D is 7.5 mm. long, moderately stout basally but tapering rather rapidly in the proximal half and becoming slender distally, with 25 segments, which at first are twice as broad as long, becoming as long as broad after the tenth; the first four segments are strongly carinate, this carination decreasing distally and disappearing after the middle of the pinnule. P_1 is 13 mm. long, slightly stouter than P_D basally, tapering gradually and becoming slender in its distal third, with 26 segments, which at first are twice as broad as long, becoming as long as broad after the ninth and somewhat longer than broad in the terminal portion; the first seven or eight segments are rather strongly carinate, and in addition have a low sharp ridge running along the exterior surface at the base of the carinate processes. P_2 is similar to P_1 and of the same length, but the low ridge just described may be traced to about the twelfth segment. P_3 is 9 mm. long, with 19 segments, similar to the two preceding pinnules but slightly less stout: P_4 is small, 6 mm. long, tapering rapidly in the proximal half and becoming very slender distally, with 16 segments, which at first are twice as broad as long, becoming as long as broad on about the ninth, and longer than broad distally; the first six segments are carinate like those of the preceding pinnules. P_5 is similar, 5.5 or 5.0 mm. long. P_6 and the following pinnules are 6 mm. long with 17 segments, which at first are twice as broad as long, becoming about as long as broad on about the eighth, and twice as long as broad terminally; the pinnules are about as stout basally as the two preceding, tapering rapidly in the proximal half and becoming very slender distally; the carination of the proximal segments is slightly marked on the first four, later becoming restricted to the second and third segments only, and disappearing entirely from the pinnules in the outer half of the arm.

Near their tips the ambulacral lappets contain very minute calcareous reticulations of one, two, or three meshes; the perisome between the sacculi and the pinnulars is unplated.

The tentacles contain two narrow lines of spicules, one distal and one proximal, which extend to about the end of their proximal half.

Locality.—Investigator; Pedro shoal, off the western coast of India, west of Mangalore [A. H. Clark, 1909, 1912] (9, U.S.N.M., 35088 [original No. 3F], 35178 [original No. 6F], 35184 [original No. 11F], 35192 [original No. 7F], 35209 [original No. 8F], 35210 [original No. 2F]; I. M.).

History.—This species was first described in 1909 and was redescribed and figured in 1912. It is as yet known only from the nine specimens collected by the *Investigator* on Pedro Shoal.

HETEROMETRA MADAGASCARENSIS (A. H. Clark)

PLATE 29, FIGURES 120–122

Craspedometra madagascarensis A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 8 (southeastern Africa), p. 23 (description; Madagascar); vol. 43, 1912, p. 381 (cotype in the U.S.N.M.), p. 384 (original reference), p. 393 (Madagascar; description of specimens other than the type); Crinoids of the Indian Ocean, 1912, p. 119 (synonymy; Madagascar).

Heterometra madagascarensis A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78 (in key; range); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 99 (range), p. 104.

Heterometra madagascariensis GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 48.

Diagnostic features.—The brachials are distinctly wedge-shaped, with the ends never quite parallel, and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are 25–30 mm. long with 34–36 segments of which the longest are somewhat longer than broad and the outer are broader than long and bear small but prominent dorsal spines. The 16 arms are 130 mm. long. P_2 is 12 mm. long, with 27 segments. P_3 is similar to P_2 but is very slightly larger and longer.

Description.—The centrodorsal is thick discoidal with the bare polar area slightly convex, 4 mm. in diameter. The cirrus sockets are arranged in two closely crowded irregular marginal rows.

The cirri are XVI, 34–36, from 25 to 30 mm. in length, stout basally, and tapering slightly in the proximal half. The first segment is short, and those following slowly increase in length to the eighth or tenth, which varies from only slightly broader than long to one-third again as broad as long, the distal segments being slightly shorter again. From the eleventh to the fifteenth (usually from about the fourteenth) onward small but prominent dorsal spines are developed. The opposing spine is larger than the spine on the preceding segment, triangular in lateral view with the apex subterminal, arising from the whole dorsal surface of the penultimate segment, and equal in height to about one-half of its width. The terminal claw is somewhat longer than the penultimate segment, moderately slender, especially in the distal two-thirds, and rather strongly curved proximally but becoming straighter distally.

The radials are concealed by the centrodorsal. The IBr_1 are very short, band-like, in apposition laterally. The IBr_2 (axillaries) are very broadly pentagonal, twice as broad as long, with the lateral borders only half as long as those of the IBr_1. The IIBr series are 4(3+4). The division series and the first brachials are in close lateral apposition and laterally flattened, their lateral borders being moderately produced. The synarthrial tubercles are obsolete.

The 16 arms of the type specimen are 130 mm. long. The first brachials are slightly wedge-shaped, twice as broad as long exteriorly, entirely united interiorly. The second brachials are of about the same size, but are more obliquely wedge-shaped. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly, twice as broad as the exterior length. The next three or four brachials are oblong, three times as broad as long, those following becoming very obliquely wedge-shaped, twice as broad as long, after the proximal fourth of the arm gradually becoming less obliquely wedge-shaped, but never oblong. The eighth and ninth and following brachials have slightly produced distal edges, this feature gradually dying away after the middle of the arm.

P_D is 9.5 mm. long, more slender than P_1, tapering more rapidly from the base and therefore more slender in its outer portion, and is composed of 32 segments of which the earlier are short, becoming about as long as broad on the twelfth and following. The second-fourth segments are strongly carinate, and those following are narrowly carinate to about the middle of the pinnule. P_1 is slender, becoming very delicate in the distal half, 10 mm. long with 26–28 segments of which the first is short and those following gradually increase in length so that the eighth and following are about as long as broad. The second-fourth segments are rather strongly carinate. P_2 is 12 mm. long, very slightly stouter basally than P_1 but tapering much more gradually and so appearing considerably stouter, with 27 segments, which become about as long as broad on the sixth and from one-third to one-half again as long as broad distally. P_3 is similar to P_2 but very slightly larger and longer. P_4 is 8 mm. long, resembling P_2 and P_3 but tapering more rapidly and therefore more slender in the distal half. P_5 is 6 mm. long, small and weak, with 16 segments all but the outermost of which are broader than long. The following pinnules are similar, gradually increasing in length and in the length of the component segments.

The distal pinnules are exceedingly slender, 8 mm. long. On the large lower pinnules the second-fifth segments are rather strongly carinate, this feature decreasing rather rapidly distally, being soon confined to the second-fourth and then to the second-third, disappearing at the end of the proximal fourth of the arm.

The color in alcohol is brownish white, the cirri being lighter and tinged with purple.

Notes.—A second specimen has 18 arms about 90 mm. long. Six IIBr series are present, of which five are 4(3+4) and one is 2. One of the IIBr 4(3+4) series bears internally a IIIBr 2 series. The IIBr 2 series bears a IIIBr 4(3+4) series externally. The color is purple.

The third example has 13 arms 65 mm. long, the three IIBr series being 4(3+4). The cirri are XVI, 32–33, 20 mm. long. The color is brownish white, the cirri light purple.

Remarks.—This species is easily distinguished from *Heterometra africana* by the tapering cirri which bear shorter dorsal spines, by the much more slender lower pinnules, and by the longer wedge-shaped brachials.

Locality.—Madagascar; Doctor Voeltzkow [A. H. Clark, 1911, 1912, 1918] (3, U.S.N.M., 35216; Berl. M., 5348).

History.—This species was described as *Craspedometra madagascarensis* in 1911, and in 1912 notes were given on two additional specimens that had been collected with the type. In the key to the species of the genus *Heterometra* given in the report on the unstalked crinoids collected by the *Siboga* published in 1918 this form was included as a member of that genus.

HETEROMETRA AMBOINAE (A. H. Clark)

Plate 29, Figure 123; Plate 31, Figures 131–136

Antedon ludovici (part) Hartlaub, Nova Acta Acad. German., vol 58, No. 1, 1891, p. 6 (with *A.* [*Stephanometra*] *oxyacantha* the most usual *Antedon* species of Amboina), p. 11 (collected by Brock at Amboina), p. 15 (very common at Amboina), p. 19 (in key), p. 29 (detailed description of specimens from Amboina; discussion and comparisons), p. 113 (in Göttingen Mus.), pl. 1, figs. 7, 8, 11.—Koehler, Rev. Suisse Zool., vol. 3, 1895, p. 286 (Bay of Amboina).—?Döderlein, Denkschr. med.-nat. Ges. Jena, vol. 8, pt. 5, 1898, p. 477 (Amboina).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, pl. 12, fig. 5 (from Hartlaub).

Craspedometra amboinae A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 35 (=*Antedon ludovici* P. H. Carpenter, 1888, in part), p. 119 (=*A. ludovici* Hartlaub, 1891, in part; description [from Hartlaub]; Amboina).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, p. 83 (Amboina; Ceylon), p. 99 (description of a specimen from Ceylon collected by Sarasin), p. 100 (comparisons).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78, footnote 1.

?*Heterometra reynaudii* (part) H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 85 (3 larger specimens).

Heterometra amboinae A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 23.

Diagnostic features.—The brachials are distinctly wedge-shaped with the ends never quite parallel, and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri have 28–40 (usually 30–35) subequal segments all of which are about twice as broad as long. The 13–23 (usually

17–19) arms are 105–180 mm. long. P_2 and P_3 have 26–31 segments; P_3 is usually, though not always, longer than P_2.

Description.—The centrodorsal is large, slightly convex, with the dorsal pole often finely pitted. The cirrus sockets are arranged in two irregular rows.

The cirri are about XXV, 35–40, about 35 mm. long; none of the cirrus segments are longer than broad; the outer bear small dorsal tubercles, and the terminal sometimes prominent spines.

The radials are plainly visible in the angles of the calyx, or entirely concealed. The IBr_1 are entirely united laterally. The IBr_2 (axillaries) are short and pentagonal. The IIBr series are usually 4(3+4), more rarely 2. IIIBr series, usually developed only interiorly, are 2, but 4(3+4) when following a IIBr 2 series. Synarthrial tubercles are moderately developed. The division series are laterally free, though sometimes very close together.

The 16–22 elongated arms are 180 mm. long, some of them arising direct from the IBr axillaries. The brachials are short; the first is shorter than the second; the first syzygial pair (composed of brachials 3+4) is very short; following this there is a series of discoidal brachials, and then a series of wedge-shaped brachials, the latter becoming progressively shorter, and short-oblong after the middle of the arm. The brachials are only slightly overlapping. The bases of the arms are rugose.

Syzygies occur between brachials 3+4, again somewhere between the eleventh and nineteenth brachials, and distally at intervals of from 7 to 11 muscular articulations. In the arms arising directly from a IBr axillary the second syzygy is between brachials 9+10, more rarely between brachials 16+17, and the distal intersyzygial interval is usually 7 or 8 muscular articulations.

P_1 or P_D is 8 or 9 mm. long. P_2 is usually much longer, 18 mm. long, almost as long as P_3. P_4 is variable, but usually smaller. The following pinnules decrease in length to P_7, which is 7 or 8 mm. long. The distal pinnules are 14 mm. long. The proximal segments of the pinnules in the basal third of the arm are strongly carinate. The enlarged lower pinnules are moderately stiffened. P_2 is composed of about 20 sharply carinate segments, none of which are longer than broad. P_D and P_1 are very slender and flagellate after the first few segments.

Notes.—The specimen from the Danish Expedition to the Kei Islands station 90 has 19 arms 165 mm. in length. The cirri have 34–36 segments. P_3 has 29 segments. P_4 is smaller with 26 segments. On one arm the thirty-second brachial bears an irregular series of small ossicles which collectively serve as an axillary; beyond this the main arm continues at a slight angle and another arm, of almost the same size, extends outward dorsally at right angles to the main arm stem.

In one of the specimens from the Danish Expedition to the Kei Islands station 31 there are 21 arms; the 10 IIBr series are all 4(3+4) and there is a single IIIBr 2 series developed internally. Another specimen has 19 arms; of the nine IIBr series present eight are 4(3+4) and one is 2. The cirri are XVIII, 31–33. A third example has 18 arms; of the eight IIBr series present one is 4(3+4), six are 2, and one consists of a single axillary only. The cirri are XVIII, 28–31. The fourth specimen has 13 arms, there being 3 IIBr 4(3+4) series. The cirri are XVII, 28–30.

One of the specimens from the Danish Expedition to the Kei Islands station 38 has 22 arms 110 mm. long. There are 10 IIBr 4(3+4) series and two IIIBr 2 series, both internally developed. The centrodorsal has the dorsal pole slightly convex, 4.5 mm. in diameter. The cirri are XVI, 28–31.

In another specimen from station 38 the 21 slender arms are 135 mm. long. Of the 10 IIBr series eight are 4(3+4) and two are 2. The two IIBr 2 series are on the same postradial series; one of them bears internally a IIIBr 2 series. The centrodorsal is discoidal with the flat dorsal pole 5 mm. in diameter. The cirri are XX, 29–34; the segments are subequal, about twice as broad as long; there are small but prominent dorsal tubercles on the last 12 to 15. P_1 is composed of 44 segments, tapering rapidly on the first seven or eight segments and then becoming flagellate; the basal segments are short, and those in the distal third are about as long as broad; the second-seventh segments are narrowly but sharply carinate. P_2 resembles P_1 but is slightly longer and tapers more regularly so is less slender distally; the segments become as long as broad on the eighth; the second-seventh segments bear a high carination with a straight crest, and the second segment also has a lateral carinate process. P_3 is about 18 mm. long; it is stouter than the preceding pinnules and tapers more slowly; it is composed of 31 segments which become as long as broad on the eighth and twice as long as broad distally; the second-seventh segments are carinate, the crest of the keel, which disappears in the middle of the seventh segment, being straight and parallel to the axis of the segments.

The third specimen from station 38 has 13 arms 105 mm. long. There are three IIBr 4(3+4) series. The cirri are XV, 29–30, from 20 to 24 mm. long.

One of the specimens collected by the Danish Expedition to the Kei Islands at Amboina Bay has 18 arms 165 mm. long. Of the six IIBr series present four are 4(3+4) and two are 2. The two IIIBr 2 series are both internally developed. The centrodorsal is discoidal with the dorsal pole flat, 4 mm. in diameter; the cirrus sockets are arranged in two rows. The cirri are XXIII, 33, 30 mm. long. The cirrus segments are subequal, all being about twice as broad as long. The 12 to 16 segments preceding the penultimate have a low blunt median carination the crest of which rises distally so that in lateral view the outer portion of the cirri appears roundedly serrate. The opposing spine is prominent, much larger than the process on the preceding segment, conical, arising from the entire dorsal surface of the penultimate segment, and directed slightly forward. Occasionally it is much shorter with a chisel-shaped edge, or forked.

Another specimen from Amboina Bay has 23 arms. There are six IIBr 4(3+4) series and seven IIIBr 2 series; of the latter six are internal and one is external, developed by the side of an internal one. The centrodorsal is flat, discoidal, with the dorsal pole 3 mm. in diameter; the cirri are in two irregularly alternating rows. The cirri are XIX, 33–38, from 30 to 35 mm. long, slightly slenderer than in the specimen described immediately above.

A third specimen from Amboina Bay has 19 arms 120 mm. long. There are six IIBr 4(3+4) series and three IIIBr 2 series, all the latter internally developed. The cirri are XVII, 33, 30 mm. long. The color is dark purple, the outer two-thirds of the arms banded purple and flesh color in bands about 3 mm. broad. The arm bases are more or less mottled and banded with flesh color. The cirri are flesh color in the proximal half or two-thirds, purple distally, sometimes also purple just at the base.

A fourth specimen from Amboina Bay has 21 arms 105 mm. long. The cirri are XIX, 28–30, from 20 to 25 mm. long.

A fifth example from Amboina Bay has 17 arms 120 mm. long. The six IIBr series are 4(3+4), and the single internally developed IIIBr series is 2.

A sixth specimen from Amboina Bay has 18 arms about 100 mm. long. Of the seven IIBr series present four are 4(3+4) and three are 2. The single IIIBr 2 series is internally developed.

The seventh specimen from Amboina Bay has 14 arms. Of the four IIBr series two are 4(3+4) and two are 2. The cirri are XXI, 34–39, from 28 to 32 mm. long.

The five specimens from the breakwater at Amboina have 21, 18, 18, 18, and 12 arms, which in the largest are 120 mm. long.

The description of the species included herein is that given by Hartlaub for the 12 specimens collected by Brock at Amboina.

Professor Strubell's specimen from Amboina, recorded by Reichensperger, is much broken. It has about 15 arms and XXII cirri. The color in alcohol is chocolate brown.

The specimen from Singapore has 13 arms, which were probably between 70 and 80 mm. long; there are three IIBr 4(3+4) series just appearing. The cirri are 20–25 mm. long and consist of 31–35 segments. This is apparently a young example of this species.

Reichensperger said that in the specimen from Ceylon the centrodorsal is large with a slightly concave dorsal pole and bears cirri in two irregular rows. The dorsal pole bears isolated pits about its border. The cirri are XXIV, about 36, and are 30 mm. long. The segments are broader than long and from the thirteenth onward bear a blunt dorsal tubercle, which on the last 8 to 10 becomes a prominent spine. When viewed from above the cirri are seen to taper far less than those of *Craspedometra acuticirra*. The 16 arms are about 140 mm. long. The structure of the distal brachials and pinnules recalls that shown in Hartlaub's figure. P_D reaches about 7 mm. in length and consists of about 20 segments of which the four lowest are broad and sharply keeled, the pinnule beyond that point becoming filiform. P_1 is longer, almost 12 mm. long, with 25 segments, which in the basal third of the pinnule are laterally and distally keeled. P_2 is the longest pinnule, about 17 mm. long with 26 segments, and is likewise keeled. P_3 is smaller than P_2 but somewhat longer than P_1, with about 23 segments. P_4 is 7 mm. long, with 17 segments; like the next following pinnules, it is keeled at the base. Reichensperger remarked that this species is strongly differentiated from *Craspedometra acuticirra*.

Professor Koehler said that the numerous specimens of this species sent to him by M. Bedot are not absolutely identical with those studied by Hartlaub. The cirri are XXV–XXVIII, with often 33–34, but rarely more than 35, segments. The IIBr series are sometimes 2, sometimes 4(3+4). The IIIBr series, which are rarely present, are 2. In contrast to what had been written by Hartlaub, Koehler found, though rarely, IIIBr 2 series following IIBr 2 series. Very marked synarthrial tubercles are present. The arms are 14–22 in number and reach 150 mm. in length. The first syzygy is between brachials 3+4, and the second is at about brachials 9+10 in arms arising directly from a IBr axillary, but at about brachials 17+18 or 18+19 in arms arising from a IIBr or IIIBr axillary. P_1 is short. P_2 is much longer, and a little smaller than P_3, which is the longest pinnule. P_4 is nearly the size of P_2, but the length of the pinnules decreases abruptly beyond P_5. The color is dark purple-violet.

The two specimens of *Antedon ludovici* recorded by Döderlein from Amboina probably represented this species and not *Craspedometra acuticirra.*

Localities.—Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 90; Sebesi Strait, between Java and Sumatra; 36 meters; hard bottom; August 1, 1922 (1).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Station 31; about 50 meters; sand; April 19, 1922 (4).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 38; about 35 meters; sand; April 24, 1922 (3).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Amboina Bay; about 50 meters; stones and sand; March 2, 1922 (7).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Amboina; breakwater; about 1 meter; February 28, 1922 (5).

Amboina; Dr. J. Brock, 1884–'85 [Hartlaub, 1891].

Amboina; Professor Strubell, 1890 [Reichensperger, 1913].

Bay of Amboina; Maurice Bedot and C. Pictet [Koehler, 1895; A. H. Clark, 1912].

?Amboina; Prof. Richard Semon [Döderlein, 1898].

Singapore; Svend Gad, December 12, 1906 (1, C. M.).

Ceylon; Doctor Sarasin, 1886 [Reichensperger, 1913].

Geographical range.—From the Kei Islands, Amboina, and Singapore westward to Ceylon.

Bathymetrical range.—From the shoreline down to about 50 meters.

History.—In 1891 Dr. Clemens Hartlaub described in detail and figured a species represented by 12 specimens, which had been collected by Dr. J. Brock at Amboina in 1884–85. He had at first considered this form as new, but later he decided that it represented Carpenter's *Antedon ludovici,* so he published the long description which he had prepared under that name.

In 1895 Prof. René Koehler recorded, under the name of *Antedon ludovici,* and gave notes upon a number of specimens collected at the Bay of Amboina by Maurice Bedot and Camille Pictet.

In 1898 Prof. Ludwig Döderlein recorded two specimens of *Antedon ludovici* that had been collected by Prof. Richard Semon at Amboina. These probably represented the present species.

A study of the type specimens of Carpenter's *Antedon ludovici, A. acuticirra* and *A. bipartipinna* at the Hamburg Museum in 1910 had convinced me that all three represent the same species, and furthermore that this species is quite different from that represented by Hartlaub's specimens from Amboina. Accordingly in my memoir on the crinoids of the Indian Ocean published in 1912 I named the species from Amboina *Craspedometra amboinae* on the basis of Hartlaub's description, which I quoted.

In 1913 Dr. August Reichensperger remarked that *amboinae* is clearly differentiated from Carpenter's *acuticirra,* and under the heading *Craspedometra amboinae* he recorded and gave notes on a specimen collected by Dr. Sarasin in Ceylon in 1886, and mentioned another collected by Professor Strubell at Amboina in 1890.

In his account of the crinoids from Ceylon in the collection of the Colombo Museum (1915) Dr. Hubert Lyman Clark mentioned three specimens of *Heterometra reynaudi* that were noticeably larger with longer arms than the others. These may possibly have been specimens of *H. amboinae.*

In 1918 *amboinae* was inserted in the key to the species of the genus *Heterometra* in the *Siboga* report but was not mentioned further as it was not secured by the *Siboga.* In a footnote under *Heterometra ater* as it appears in this key, I said that the specimen from Ceylon described by Reichensperger under the name of *Craspedometra amboinae* appears to belong to this species; at any rate it is closely related to it. I am now convinced that this is an error and that Reichensperger's specimen was correctly identified.

HETEROMETRA REYNAUDI (J. Müller)

Plate 32, Figures 137–143

[See also vol. 1, pt. 1, fig. 75 (lateral view of abnormal specimen), p. 128; fig. 257 (centrodorsal), p. 255; fig. 472 (radial pentagon), p. 361; pt. 2, figs. 45, 46 (radial pentagon), p. 26; figs. 451, 452 (pinnule tip), p. 261].

?*Alecto horrida* Leach, Zool. Misc., vol. 2, 1815, p. 61, pl. 80.—Schweigger, Beobachtungen au naturhistorischen Reisen, 1819, p. 66, pl. 4, figs. 39–42.—Guilding, Zool. Journ., vol. 4, 1829, p. 173.—Leuckart, Zeitschr. organ. Physik, vol. 3, Heft 4, 1833, p. 385, footnote.—[Anonymous], Penny Encylopedia, vol. 7, 1837, p. 391.—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, part 1, Dec. 1879, p. 4.— A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 450; Crinoids of the Indian Ocean, 1912, pp. 2, 280.

?*Comatula horrida* J. Müller, Monatsb. preuss. Akad. Wiss., April 1840, p. 6; Archiv. Naturg., 1840, vol. 1, p. 311.

?*G. horrida* J. Müller, L'Institut, 17 Sept. 1840, p. 394.

Comatula (*Alecto*) *reynaudi* J. Müller, Monatsb. preuss. Akad. Wiss., 1846, p. 178 (description; Ceylon); Abh. preuss. Akad. Wiss., 1847 (1849), p. 259 (redescribed).

Comatula reynaudi Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 205 (synonymy; description; Ceylon).

Antedon reynaudii P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*).

Antedon reynaudi Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 743 ff (discussion of Bell's method of formulation and corrected formula).—Bell, Sci. Trans. Roy. Dublin Soc., ser. 2, vol. 3, 1887, p. 645 (Ceylon).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 43, 55, 252, 255, 366, 380 (discussion).—Bell, Proc. Zool. Soc. London, 1888, p. 384 (Tuticorin, Madras), p. 387 (occurs in the Bay of Bengal).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 17 (in key).—Thurston, Madras Gov. Mus. Bull., No. 2, 1894, p. 114 (Pambán; on stems of gorgoniae).—Chadwick, Rep. Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon), p. 156 (station xxxiv; detailed description), plate, figs. 6–12.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 35, 40 (identity of previous records).

Antedon renaudi Thurston, Madras Gov. Mus. Bull., No. 2, 1894, p. 106 (Gulf of Manaar; littoral).

Antedon variipinna Chadwick, Rep. Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon), p. 157 (station II; characters).

Himerometra reynaudi A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 356 (listed); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 11 (listed); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 25 (compared with *H. joubini*).

Heterometra reynaudii A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 245 (identity), p. 251 (Ceylon; description of type; compared with *H. joubini*); Mem. Australian Mus., vol. 4, 1911, p. 765, footnote (recorded by Chadwick from Ceylon as *Antedon variipinna*); Rec. Indian Mus., vol. 7, pt. 3, 1912, No. 26, p. 268 (India; ?India; descriptions of specimens); Crinoids of the Indian Ocean, 1912, pp. 30, 35, 40 (identity of previous records), p. 121 (synonymy; new localities; descriptions; specimens deficient in lime; parasitic *Eulimas*), fig. 9 (p. 122), p. 317 (additional locality; descriptions); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 27 (published references to specimens in the British Museum; Tuticorin; notes).—H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 85 (Ceylon; 55 specimens, 3 noticeably larger with longer arms than the rest), p. 93 (occurs at Ceylon).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 79 (in key; range); Journ. Linn. Soc. (Zool.), vol. 36, No. 249, May 1929, p. 638 (South Male).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 27.

Comatula (*Alecto*) *reynaudii* A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 245 (identity); Crinoids of the Indian Ocean, 1912, p. 30 (same).

Heterometra bengalensis A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 130 (south of Ceylon; Andaman Is.; notes), p. 318 (off Gopalpore, 25–28 and 30–38 fathoms; ?India; notes), fig. 12, p. 131.—H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 93 (part; occurs at Ceylon).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 79 (part; in key; range).

Heterometra reynaudi Pelseneer, Bull. Soc. Zool. France, vol. 53, 1928, p. 173 (parasitized by *Eulima* [*Sabinella*], sp.).—A. H. Clark, Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 556 localities; notes).—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 100 (range), p. 103.

Diagnostic features.—The brachials are distinctly wedge-shaped with the ends never quite parallel and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are 25–27 mm. long and are composed of 30–47 (usually in fully grown individuals more than 40) subequal segments, all of which are somewhat broader than long, commonly twice as broad as long, and of which the outer bear prominent sharp dorsal spines. The 14–25 (usually 17–20) arms are up to 110 mm. long. P_2 is the largest pinnule with 27 segments. P_3 is about the size of P_1, both having 29 segments.

Description.—The centrodorsal is a thick disk with a convex dorsal surface, bearing the cirri in two alternating rows on its sloping sides.

The cirri are XXV, 35–36, all but a few immature ones being rather more than 20 mm. long. All the segments are slightly broader than long, the later ones being laterally compressed and bearing, from the fourteenth onward, a strong and distally directed dorsal spine. The relative length of the cirrus segments varies considerably. Usually all the cirrus segments are subequal, all being about twice as broad as long, but sometimes they are longer, the segments in the proximal half of the cirri being in extreme cases nearly as long as broad.

The radials are entirely concealed. The IBr_1 are just visible above the bases of the cirri and are in almost complete lateral contact. The IBr_2 (axillaries) are broadly pentagonal, and are about half again as long as the IBr_1. In the specimen described two of the postradial series bear two IIBr 4(3+4) series, two bear each a single IIBr 4(3+4) series, and the fifth bears two IIBr 2 series. Of the eight IIBr series present, therefore, six are 4(3+4) and two are 2. The first elements of the IIBr series are in almost complete lateral contact, and there is a slight synarthrial tubercle on the articulation between the first and second elements.

The 18 arms are probably 110 mm. long and are composed of about 200 short and slightly overlapping brachials. The first brachials are in almost complete contact interiorly. The first eight brachials are discoidal and are succeeded by about 30 shortly triangular brachials, which are followed by discoidal ones, these continuing to the tip of the arm. The distal ends of the brachials are usually very finely spinous, though not produced. In specimens from the east coast of India they are occasionally slightly produced and rarely considerably produced and everted.

Syzygies on six arms occur as follows:

1. Between brachials 3+4, 13+14, 21+22, 28+29, 37+38, 47+48, 56+57, 65+66, and 74+75.
2. Between brachials 3+4, 9+10, 14+15, 21+22, 29+30, 33+34, 41+42, 49+50, 63+64, 72+73, 77+78, 84+85, and 92+93.
3. Between brachials 3+4, 15+16, 25+26, 34+35, and 42+43.
4. Between brachials 3+4, 15+16, 25+26, 35+36, 50+51, and 60+61.
5. Between brachials 3+4, 16+17, 23+24, 31+32, and 38+39.
6. Between brachials 3+4, 7+8, and 31+32.

P_D is about 10 mm. long and is composed of 31 segments of which the first seven are broad, flattened, and carinate, the later ones gradually becoming cylindrical, longer than broad, and with rounded ends. P_1 and P_3 are about equal in size, and P_a and P_c resemble them. P_1 and P_3 have about 29 segments. P_2 and P_b are the largest pinnules on the arm, P_2 being about 15 mm. long, but having 27 segments only. The basal segments of the first three pairs of brachial pinnules are flattened and more or less carinate. P_5 and P_e are the shortest pinnules, the pinnules succeeding gradually increasing in length. The carination on the basal segments of the earlier pinnules, usually moderate or rather slight, is occasionally much exaggerated.

The disk is 10 mm. in diameter and is considerably incised. The ambulacra are naked. Sacculi are abundant and closely set on the arms and pinnules, but are absent from the disk.

In alcohol the disk is chocolate-brown, fading to white in the interambulacral angles. The brachials are pinkish, with the articulations in the proximal fourth of the arms marked with bands of deep reddish brown, which gradually fade into dots on the sides of the arms. The pinnules are irregularly banded with brown and white.

The preceding description is adapted from Chadwick and is based upon the single specimen secured at the Ceylon Pearl Oyster Fisheries station XXXIV.

Notes.—The two specimens from South Male are both small 10-armed individuals the identity of which must be considered as somewhat doubtful.

Müller's description of the type specimen is as follows: The centrodorsal is flat, bearing marginal cirri. The cirri are about XX, 40; the segments gradually develop a dorsal tubercle. The radials are visible. The IIBr series are 4(3+4). The 20 arms are 4 inches long. The distal intersyzygial interval is usually eight muscular articulations. P_2 and P_3 are longer than the other pinnules. The ventral side of the disk is soft.

Müller wrote in his description that there are three radials of which the third is axillary with a syzygy, and the same wording was given by Dujardin and Hupé in 1862. Obviously a part of what he wrote in his manuscript was omitted in the printing. What he intended to say was that there are three radials (that is, the radials are visible and are followed by the two ossicles of the IBr series) and the next division consists of three ossicles of which the third is axillary with a syzygy (that is, the IIBr series are 4[3+4]).

Carpenter in the *Challenger* report mentioned *reynaudi* as having all the outer arm divisions of two segments only, the axillaries being syzygial segments (that is, the outer arm divisions are 3[2+3]). At the time this was written he had evidently confused the type specimen of *reynaudi* with a specimen of *Capillaster multiradiata* from Trinquemale, Ceylon, which was also collected by M. Reynaud in 1829 (see Part 3, pp. 197, 204, 205). Farther on in the *Challenger* report, however, he correctly placed *reynaudi* in the *Savignyi* group and assigned to it the following characters. The IIBr series are 4(3+4). The cirri, which are without definite arrangement, have not more than 45 segments. The distal (that is, distichal, or IIBr) pinnule is generally smaller than its successors. The segments of the lower pinnules are without lateral processes. There are 40–45 cirrus segments which are mostly spiny. The distal intersyzygial interval is usually from 8 to 11 muscular articulations.

In 1910 I examined Müller's type specimen at Paris. There are 41–44 cirrus segments, which are subequal, all being about twice as broad as long. There are 19 arms, nine IIBr 4(3+4) series being present. The brachials are slightly overlapping.

Dr. Hubert Lyman Clark says that of the 55 specimens sent to him for study by the Colombo Museum three are noticeably larger than the rest with longer arms.

Of the four specimens collected by the *Investigator* south of Ceylon in 62 meters two are of medium size and one is small. The fourth is curiously abnormal (see page 307).

Of the two specimens collected by the *Investigator* south of Ceylon in 58 meters one has the cirri XIII, 24–28, and the other, with 12 arms, has the cirri XII, 21–27.

One of the 10 specimens from the entrance to Palk Strait has 14 arms, four IIBr 4(3+4) series being present. Another has 16 arms; of the six IIBr series present five are 4(3+4) and one is 2. Two have 20 arms with eight of the 10 IIBr series 4(3+4) and two 2. One has 20 arms with seven of the ten IIBr series 4(3+4) and three 2. One has 21 arms, with all the IIBr series 4(3+4) and all the IIIBr series, which are internally developed, 2. The remaining four are badly broken.

One of the four specimens from Palk Strait has 20 arms about 110 mm. long and the cirri XXV, 34–40, from 25 to 27 mm. long. Another has 21 arms (one IIIBr series being present) and the cirri XXI, 33–42. A third has 22 arms (with two IIIBr series both internally developed). The fourth has 20 arms, one of the IIBr series being absent but its loss being compensated by the development of one IIIBr series which, however, is 4(3+4) instead of the usual 2.

The specimen from *Investigator* station 90 is medium sized. That from the Ganjam coast in 44–55 meters is small with 12 arms.

Of the five specimens from off Gopalpore in 46–51 meters one has 14 arms 80 mm. long; of the four IIBr series three are 4(3+4) and the fourth is 2. The cirri have 34–41 segments. The color is white, with the articulations banded with purple; the cirri are white with the distal portion purple dorsally.

Three of the specimens have each 17 arms 80 mm. long; in all these three there are seven IIBr series. One has all seven of the IIBr series 4(3+4). The cirri have 31 segments. The color is white with a row of small brown spots, in pairs, on the sides of the proximal third of the arms. Another has six IIBr 4(3+4) and one IIBr 2 series. The cirri have 30–33 segments and are 20 to 25 mm. in length. The color is white with occasional blotches of brown on the arms. The third has five IIBr 4(3+4) and two IIBr 2 series. The color is white, the cirri, and well-separated narrow bands on the arms, being purple.

The fifth specimen has 19 arms 80 mm. long. One of the IIBr series is absent. The dorsal pole of the centrodorsal is flat, 3 mm. in diameter. The cirri are XVIII, 28–32, 20 mm. long. The color is white, the cirri, narrow bands on the arms, and a series of small regular spots on the proximal third of the arms brown.

Of the 10 specimens dredged by the *Golden Crown* off Gopalpore in 55–69 meters two have 17 arms, three have 18 arms, three have 20 arms, and two have 21 arms.

Of the 17-armed specimens one has the arms 75 mm. long, and the seven IIBr series 4(3+4); the cirri are 18 mm. long and are composed of 26–28 segments; the color is white. The other has the arms 85 mm. long; the calyx and arm bases are white, the arms light yellow brown. Of the 18-armed specimens one has the arms about 75 mm. long; all the IIBr series present are 4(3+4); a IIIBr 2 series, internally developed, is present on one of the postradial series; the cirri are 23 mm. long and are composed of 32–36 segments; the color is light yellow-brown. Another has the arms 90 mm. long; the cirri are 23 mm. long and are composed of 30 segments; the color is white. The third has the arms 110 mm. long; one postradial series is without IIBr series; of the eight IIBr series present seven are 4(3+4) and one is 2; the cirri are 23 mm. long and composed of 30–33 segments.

One of the 20-armed specimens has the arms 70 mm. long; the color is white, becoming yellow-brown on the arms, with the pinnules purple. Another has the arms 85 mm. long; the 10 IIBr series are 4(3+4); the cirri are 20 mm. long and are composed of 25–27 segments; the color is white with the proximal portion of the arms spotted along the sides and the remainder of the arms narrowly banded with purple; the cirri are brown. The third has the arms 115 mm. long; the 10 IIBr series are all 4(3+4); the cirri are XIV, 33–34, 25 mm. long; the color is white with faint purplish blotches on the arms, the cirri being purple.

One of the 21-armed specimens has the arms 75 mm. long; the 10 IIBr series are 4(3+4); the single internally developed IIIBr series is 2; the color is white, with the cirri deep purple. The other 21-armed specimen has the arms 80 mm. long; the 10 IIBr series are 4(3+4); the single IIIBr series, which is developed internally, is 2, the calyx and arm bases are white, the arms are yellow-brown, and the cirri purple.

The specimen from Puri Beach, Orissa, has 16 arms.

The two specimens from Tuticorin in the British Museum are fine examples of the species. One has 18 arms 90 mm. long and the cirri 25 mm. long; one of the IBr series carries no IIBr series. The other has 17 arms.

The specimen from Tuticorin Harbor collected by Dr. H. S. Rao has 17 arms.

Of the three specimens from east of the Terribles two have each 25 arms, five IIIBr 2 series being present all developed internally. The third is smaller with only 13 arms.

The two specimens from the Arrakan coast each have 22 arms, two IIIBr series being developed, both internally. One has 35–42 and the other 47 cirrus segments. The specimen presumably from the Arrakan coast is medium sized.

The two specimens from the Andaman Islands are similar to those from south of Ceylon. One has 14 arms and 26 cirrus segments, and the other has 15 arms and 22 or 23 cirrus segments.

Of the three specimens labeled India one has 20 arms about 65 mm. long; of the 10 IIBr series, nine are 4(3+4) and one is 2. Another has 12 arms 25 mm. long; there are 15–18 cirrus segments of which the fifth or sixth and following bear dorsal spines. The third is medium sized.

Of the 10 specimens labeled ?India, which are probably from Ceylon, 6 are of medium size and 4 are very small. One of the latter has 10 arms 15 mm. long; the cirri are XIV, the longest with 17 segments of which the ninth and following bear dorsal spines, the shorter with 12 segments none of which bear dorsal spines. Another also has 10 arms; the longest cirri are 10 mm. long and are composed of 22 segments, dorsal spines being developed from the seventh segment onward; the smallest cirri are 2.5 mm. long with nine segments, quite without dorsal spines and exactly resembling the cirri of young examples of *Antedon bifida*. A third has 12 arms 25 mm. long.

Abnormal specimen.—In a specimen from south of Ceylon the centrodorsal and division series are of normal size and shape. One cirrus remains which tapers to a point at the seventeenth segment; no dorsal spines are developed. The 19 arms, which are only 17 mm. long, are of normal size basally but rapidly taper to a point beyond which they are continued for a short distance in a slender and soft uncalcified process. The lower pinnules taper very rapidly for the first five or six segments, from that point onward being very slender and hairlike with little or no lime in their composition. Beyond the arm bases the pinnules are exceedingly slender with never more than the first or first two segments of normal size, usually with none, and commonly with traces of calcareous deposits showing segmentation, though often quite without any. With the reduction of the calcareous material in the pinnules comes a reduction in the pinnule sockets, the noncalcareous pinnules in the outer portion of the arm not being accompanied by any modification in the outer edge of the brachials whatever. Most of the arms of this specimen have been broken off and repaired at the syzygy between the third and fourth brachials.

A marked shortening of the arms, which then taper abruptly, is occasionally noticed in multibrachiate comatulids, though it does not reach anything like the extent seen in this individual. Instances are seen in the specimen of *Capillaster macrobrachius* collected by the *Siboga* (see Part 3, p. 159, and compare figs. 26 and 25, pl. 8), and in the specimens of *Himerometra robustipinna* from Ceylon (recorded by Reichensperger as *H. kraepelini;* see page 199) and Akyab, Burma (the type of Hartlaub's *Antedon kraepelini;* see page 198).

Parasite.—Two of the specimens from Palk Strait are parasitized by small mollusks of the genus *Sabinella*, which are attached to the cirri near the base (see Part 2, p. 648).

Localities.—South Male, Maldive Islands; Prof. J. Stanley Gardiner [A. H. Clark, 1929] (2, B.M.)

Ceylon; M. Reynaud, *Chevrette* expedition, 1829 [J. Müller, 1846, 1849; Dujardin and Hupé, 1862; P. H. Carpenter, 1879, 1883, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912] (1, P.M.).

Ceylon [Bell, 1887].

Ceylon [H. L. Clark, 1915] (55, M.C.Z., 603, 604, 610; Colombo Mus.).

West coast of Ceylon; Ceylon Pearl Oyster Fisheries station II; from 7 to 14 miles north of Negombo, 5 miles off shore; 15–16 meters; coarse yellow sand, shells, stones, and small coral; temperature 25.28° C.; specific gravity 1.023 [Chadwick, 1904].

South coast of Ceylon; Ceylon Pearl Oyster Fisheries station XXXIV; Welligam Bay, various parts; 4–13 meters; shell sand and a little mud; temperature 25.44° C.; specific gravity 1.0225 [Chadwick, 1904] (1, U.S.N.M., 35211).

Investigator; south of Ceylon (lat. 6° 01′ N., long. 81° 16′ E.); 62 meters [A. H. Clark, 1912] (4, U.S.N.M., 35091, 35106; I.M.).

Investigator; south of Ceylon (lat. 6° 06′ 30″ N., long. 81° 23′ E.); 58 meters [A. H. Clark, 1912, 1918; H. L. Clark, 1915] (2, U.S.N.M., 35187 [original No. 4D]; I.M.).

Gulf of Manaar; littoral; Edgar Thurston [Thurston, 1894].

Investigator; entrance to Palk Strait, between northeastern Ceylon and India; Point Pedro bearing southsoutheast, distant about 3 miles; 11–15 meters; sandy bottom; 1893–1894 [A. H. Clark, 1932] (1, I.M.).

Investigator; off northeastern Ceylon; entrance to Palk Strait; Point Pedro bearing southsoutheast, about 3 miles distant; 11–15 meters; sandy bottom [A. H. Clark, 1912] (10, U.S.N.M., 35762, 36256; I.M.).

Investigator; Palk Strait, northeastern coast of Ceylon [A. H. Clark, 1912] (4, U.S.N.M., 35108 [original No. 4897–7], 35185 [original No. 5E], 35191, 35208 [original No. 4898–7]; I.M.).

Investigator station 90; off the Ganjam coast, Madras presidency; 8 miles east-southeast of Kalingapatam lighthouse; 51–55 meters; sand and shells; February 17–21, 1890 [A. H. Clark, 1912] (1, U.S.N.M., 35078).

Bengal Fisheries steamer *Golden Crown;* Ganjam coast, Madras Presidency; 44–55 meters; March 8–16, 1909 [A. H. Clark, 1912] (2, U.S.N.M., 35092; I. M.).

Bengal Fisheries steamer *Golden Crown;* off Gopalpore; 46–51 meters [A. H. Clark, 1912] (5, U.S.N.M., 35103 [original No. ZEV 3624–7], 35113; I. M.).

Bengal Fisheries steamer *Golden Crown;* off Gopalpore; 55–69 meters [A. H. Clark, 1912] (10, U.S.N.M., 35097, 35109, 35188; I. M.).

Bengal Fisheries steamer *Golden Crown;* off Gopalpore; 55–69 meters; December 1909 [A. H. Clark, 1932] (1, I. M.).

Bengal Fisheries steamer *Golden Crown;* Puri Beach, Orissa [A. H. Clark, 1932] (1, I. M.).

Tuticorin, Madras; Edgar Thurston; littoral [Bell, 1888; Thurston, 1894; A. H. Clark, 1913] (2, B. M.).

Tuticorin Harbor; shore collecting; Dr. H. S. Rao, February–March, 1926 [A. H. Clark, 1932] (1, I. M.).

Pamban; littoral, on stems of gorgonians [Thurston, 1894].

Investigator; east of the Terribles (about 30 miles southeast ¾ south from the south point of Western Borongo Island, Burma) (lat. 19°27′ N., long. 93°18′ E.); 24 meters [A. H. Clark, 1912] (3, U.S.N.M., 35076, 35204 [original No. 67B]; I. M.).

Arrakan coast, Burma [A. H. Clark, 1912] (2, I. M.).

?Arrakan coast [A. H. Clark, 1912] (1, I. M.).

Investigator; Andaman Islands [A. H. Clark, 1912, 1918] (2, I. M.).

India [A. H. Clark, 1912] (3, I. M.).

?India [A. H. Clark, 1912] (8, U.S.N.M., 35090 [original No. 34H], 35093 [original No. 9H], 35105 [original No. 10H], 35214 [original No. 30H]; I. M.).

Investigator; ?India (probably Ceylon) [A. H. Clark, 1912] (2, U.S.N.M., 35215 [original No. 55H], 35217; I. M.).

Geographical range.—From the Maldive Islands and Ceylon northward along the western and northern shores of the Bay of Bengal and south along the eastern shore as far as Borongo Island, near Akyab, Burma.

Bathymetrical range.—From the shoreline down to 62 (?69) meters. Most of the records are littoral or sublittoral.

History.—It is probable that the *Alecto horrida* described by Dr. W. E. Leach in 1815 is in reality this species. Leach's description is very short. He says "Rays simple; tentacules of the back smooth, with the joints moderately long and produced internally. Locality unknown. British Museum."

Carpenter noted that Schweigger's figure of the disk of *Alecto horrida* shows clearly enough that the five trunks of the ambulacral grooves converge toward the center of the disk as in *Antedon bifida* and that *Alecto horrida* is therefore a true *Antedon* in the modern (1879) sense of the term, although belonging to that division of the genus in which the repetition of the bifurcation of the 10 primary arms is carried to a great extent.

Leach's figure shows a comatulid with 25 very flexible, slender, and slowly tapering arms about 90 mm. long. The drawing is sufficiently detailed to indicate that it represents, without any question, a species with the IIBr series 4(3+4) and the IIIBr series 2. The cirri are numerous, slender, and rather long, all of them being shown incurved over the centrodorsal. They are the structures referred to as the "tentacules of the back," and the expression "produced internally" indicates that the segments carry dorsal processes.

This specimen cannot belong to a species of Comasteridae, for no member of that family has such long and slender many jointed cirri and such evenly tapering and flexible arms. Nor do the four enlarged brachials and three enlarged pinnules shown suggest those of any species of Comasteridae. It is evidently an example of a species of Himerometridae belonging to the genus *Heterometra.* Among the species of *Heterometra* it agrees perfectly, so far as the details of the figure will permit us to form an opinion, with *H. reynaudi* of Ceylon, but not with any other species.

There can be little doubt that Leach's *Alecto horrida,* described in 1815, is the same species as Müller's *Comatula* (*Alecto*) *reynaudi,* although definite proof of the identity of the two is lacking.

This species was first recognizably described in 1846 under the name of *Comatula* (*Alecto*) *reynaudi* by Prof. Johannes Müller from a specimen that he had studied in the Paris Museum and that had been collected during the cruise of the *Chevrette* by M. Reynaud in Ceylon in 1829. It was redescribed by Professor Müller in 1849, and this redescription was translated and published in French by Dujardin and Hupé in 1862. In all three of these descriptions there is a curious omission of part of a sentence (see page 304), which renders them quite obscure.

In the autumn of 1876 Dr. P. H. Carpenter examined Müller's type specimen in the Paris Museum, and in 1879 he assigned this species to the genus *Antedon* as understood by him.

In October 1882 Prof. F. Jeffrey Bell proposed a specific formula for this species, which was amended by Carpenter in April of the following year.

In 1887 Professor Bell recorded additional specimens from Ceylon.

In the *Challenger* report on the comatulids published in 1888 Carpenter included this species in his key to the *Savignyi* group and also said that its outer division series are of two joints with the axillary a syzygial joint (that is, are 3[2+3]). Probably he confused the type specimen of *reynaudi* with a specimen of *Capillaster multiradiata* also collected by M. Reynaud in Ceylon, but he may have been misled by Müller's original description.

In 1888 Professor Bell recorded this species from Tuticorin, Madras, on the Indian shore of the Gulf of Manaar, whence specimens had been sent to the British Museum by Edgar Thurston of the Madras Government Museum.

In 1891 Dr. Clemens Hartlaub inserted *reynaudi* in his key to the species of the *Savignyi* group of *Antedon,* using the same characters that were used by Carpenter in 1888.

In 1894 Edgar Thurston recorded this species as living on the stems of gorgonians at Pamban, and also as being found along the shore in the Gulf of Manaar.

In 1904 Herbert Clifton Chadwick recorded it from Ceylon, where it had been dredged at one of the stations occupied during the pearl oyster investigations of the Gulf of Manaar under the direction of Sir William A. Herdman. He gave an excellent description of the species and figured it. Later in the same year he recorded it in a supplementary report from another station, the specimen concerned having been listed in the original report as *Antedon variipinna.*

In the first revision of the genus *Antedon* published by me in 1907, *reynaudi* was assigned to the new genus *Himerometra,* and in a revision of the family Himerometridae published in 1909 it was assigned to the new genus *Heterometra.*

In 1911 I published notes on Müller's type specimen, which I had examined in the Paris Museum in 1910, and in a short paper on Indian crinoids, and also in my monograph on the crinoids of the Indian Ocean, both published in 1912, I recorded and gave notes on specimens taken in Ceylon and at various places in the Bay of Bengal, described a curiously abnormal specimen, and recorded a molluscan parasite (see page 307).

Under the name of *Heterometra bengalensis* I recorded numerous additional specimens from various localities, all the specimens recorded as *bengalensis* being in reality *reynaudi.* The figure, said to represent a typical example of *bengalensis* in lateral view, was in reality drawn from a specimen of *reynaudi.*

In 1913 I gave notes on the two specimens from Tuticorin in the British Museum, and in 1915 Dr. Hubert Lyman Clark recorded 55 additional specimens from Ceylon. He said that three of these are noticeably larger and have longer arms than the rest. It is possible, or even quite probable, that these large long-armed individuals represent *H. amboinae* instead of *H. reynaudi.*

In my report upon the unstalked crinoids of the *Siboga* expedition published in 1918 I included a key to the species of *Heterometra* in which both *reynaudi* and *bengal-*

ensis are given. The characters assigned to *bengalensis* were drawn up from immature individuals of *reynaudi* from the east coast of India, which were mistaken for *bengalensis*.

HETEROMETRA ATER (A. H. Clark)

PLATE 26, FIGURES 109, 110

Alecto sovignii (part) J. Müller, Monatsb. Preuss. Akad. Wiss., 1841, p. 185; Archiv für Naturg., 1841, vol. 1, p. 144; Abh. Preuss. Akad. Wiss., 1841 (1843), p. 181.

Comatula (*Alecto*) *sovignii* J. Müller, Abh. Preuss. Akad. Wiss., 1847 (1849), p. 257 (in part).

Antedon ludovici Berl. Mus., MS. A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 21.

Craspedometra ater A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 9 (northeastern Africa), p. 21 (description; Red Sea); vol. 43, 1912, p. 383 (=*Alecto savignii* of J. Müller, in part), p. 384 (original reference), p. 393 (synonymy; description; Red Sea); Crinoids of the Indian Ocean, 1912, p. 119 (synonymy; Red Sea).

Heterometra ater A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 48.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 99 (range), p. 104.

Diagnostic features.—The brachials are distinctly wedge-shaped, with the ends never quite parallel, and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are 30–33 mm. long and are composed of 32–36 subequal segments all of which are half again as broad as long, the outer bearing a small blunt median spine. The 14 arms are about 160 mm. long. P_2 is half again as long as P_1 and much larger and stouter, 22 mm. long with 30 segments. P_3 is of the same length as P_1 and is much smaller and slenderer than P_2.

Description.—The centrodorsal is thick discoidal, with the bare polar area slightly convex, 4 mm. in diameter. The cirrus sockets are arranged in one and a partial second crowded and irregular marginal row.

The cirri are XXII, 32–36, from 30 mm. to 33 mm. in length, stout and not tapering distally. The first segment is short, and those following gradually increase in length to the fifth or sixth, which, with the remainder, is about half again as broad as long. On the fifteenth or sixteenth the middle of the distal dorsal edge becomes prominent, this prominence after one or two more segments becoming a prominent rather high rounded carination of the entire mediodorsal line. Distally this carination gradually narrows longitudinally so that on the last four or five segments preceding the penultimate there is only a blunt median spine. The opposing spine is usually rather longer and sharper than the spines on the preceding segments, terminal or subterminal, directed obliquely forward, half as long as the width of the penultimate segment. The terminal claw is somewhat longer than the penultimate segment, stout and strongly curved basally but becoming straighter and slenderer in the distal two-thirds.

The radials are almost entirely concealed by the centrodorsal in the median line, but their anterolateral portions are visible as very low broad triangles in the interradial angles of the calyx. The IBr_1 are very short, bandlike, five or six times as broad as long, in close apposition laterally. The IBr_2 (axillaries) are very broadly pentagonal, twice as broad as long. The IIBr series are 4 (3+4) and are well rounded dorsally. The division series as far as P_D are in lateral apposition, though they are not especially flattened. The synarthrial tubercles are obsolete.

The 14 arms of the type specimen are about 160 mm. in length. The first brachials are very short, slightly wedge-shaped, almost entirely united interiorly. The second brachials are larger, more obliquely wedge-shaped. The first syzygial pair (composed of brachials 3+4) is oblong, from two and one-half to three times as broad as long. The next five or six brachials are oblong, three to four times as broad as long, those succeeding becoming wedge-shaped, moderately oblique, about three times as broad as long, soon gradually becoming less and less oblique, and in the outer part of the arms being very short, three or three and one-half times as broad as long, and only slightly wedge-shaped.

P_D is 11 mm. long, with 33 segments, moderately stout basally but tapering rapidly and becoming very slender and flagellate in the distal half. The segments at first are nearly three times as broad as long, but gradually increase in length and become nearly or quite as long as broad in the distal third. P_1 is 13 mm. long, considerably stouter than P_D and tapering much less rapidly, with 26 segments, of which the second-eighth are strongly carinate. P_2 is 22 mm. long, similar in general to P_1 though much larger and stouter and tapering less rapidly, with 30 segments of which the proximal are broad and those following become about as long as broad on the tenth or twelfth and remain so until near the tip; the second-fifth segments are strongly carinate. P_3 is 13 mm. long, much smaller and slenderer than P_2. P_4 is somewhat smaller than P_3. P_5 is 9 mm. long, somewhat smaller than P_4; the proximal carination occurs on the second-sixth segments. The following pinnules very slowly become slenderer, at the same time gradually increasing in length. The distal carination of the proximal segments, which is very marked on the earlier pinnules, gradually becomes less and less marked, involving fewer and fewer segments; it is but slightly evident beyond the twentieth. The distal pinnules are 10 mm. long.

The color in alcohol is a uniform purplish or violet-black.

Locality.—Red Sea; Hemprich and Ehrenberg [J. Müller, 1841, 1843, 1849; A. H. Clark, 1911, 1912, 1918] (1, Berl. M., 1055).

History.—The single known specimen of this species was studied by Prof. Johannes Müller and is part of the material upon which he based his *Alecto savignii* described in 1841 and redescribed under the name of *Comatula* (*Alecto*) *savignii* in 1849.

Later someone—probably Dr. P. H. Carpenter—in going over the collection of the Berlin Museum discovered this specimen and separated it out from the type series of *Alecto savignii,* labeling it *Antedon ludovici.*

It was under this name that I found it in 1910. In 1911 I described it under the name of *Craspedometra ater.* In 1912 in my memoir on the crinoids of the Berlin Museum I again mentioned it, giving the early references to Müller.

In my report on the unstalked crinoids of the *Siboga* expedition it was included in the key to the species of the genus *Heterometra.* In this report I referred to *H. ater* the specimen from Ceylon identified as *Craspedometra amboinae* by Reichensperger. I am now convinced that Reichensperger's identification was correct and that the Ceylon specimen really represents *amboinae.*

HETEROMETRA JOUBINI (A. H. Clark)

Heterometra joubini A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 8 (southeastern Africa), p. 25 (description; Zanzibar); Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 251 (detailed description; Zanzibar); Crinoids of the Indian Ocean, 1912, p. 127 (synonymy; habitat); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 78 (in key; range).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 48.—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 100 (range), p. 104.

Diagnostic features.—The brachials are distinctly wedge-shaped, with the ends never quite parallel, and are not exceedingly short. The enlarged lower pinnules are smooth, with the earlier segments keeled. The cirri are 30 mm. long, with 39–43 subequal segments, all of which are about half again as broad as long and of which those in the outer half bear short dorsal spines. The 20 arms are 80 mm. long. P_2 is the longest pinnule, half again as long as P_1 or P_3, and is slender, with 21 segments.

Description.—The cirri are XXII, 39–43, 30 mm. long. The segments are all subequal, about half again as broad as long. Those in the outer half of the cirri bear short dorsal spines. The cirri as a whole are comparatively long and moderately stout.

Ten IIBr series of 4(3+4) are present. The arm divisions and the arm structure are as in *H. reynaudi.*

The 20 arms are 80 mm. long.

P_2 is the longest pinnule, half again as long as P_1 or P_3, slender, with 21 segments, which become about as long as broad on the fourth or fifth, then somewhat longer than broad, and elongate terminally. P_3 is about as long as P_1. P_4 and the following pinnules are shorter than P_3. The lower segments of the proximal pinnules are moderately carinate.

Remarks.—When compared directly with Müller's type specimen of *H. reynaudi* this species is seen to differ in its longer and somewhat more slender cirri, which are composed of slightly longer segments.

Locality.—Zanzibar; M. Rousseau, 1841 [A. H. Clark, 1911, 1912, 1918] (1, P. M.).

History.—The type specimen of this species was examined by Dr. P. H. Carpenter during a visit to the Paris Museum, and he placed a label with it indicating that it represented a new species. He did not, however, mention it in any of his publications. It was first described in 1911 in a memoir on the crinoids of the coasts of Africa and also in a report on the recent crinoids in the Paris Museum.

HETEROMETRA PHILIBERTI (J. Müller)

PLATE 28, FIGURES 118, 119; PLATE 30, FIGURES 124–126

[See also vol. 1, pt. 1, fig. 258 (centrodorsal), p. 255; fig. 335 (cirrus), p. 283; fig. 473 (centrodorsal), p. 361; pt. 2, figs. 34–36 (radial pentagon), p. 20; figs. 447, 448 (pinnule tip), p. 261.]

Comatula philiberti J. MÜLLER, Abh. Preuss. Akad. Wiss., 1847 (1849), p. 259 (description; Java).—DUJARDIN and HUPÉ, Histoire naturelle des zoophytes, Échinodermes, 1862, p. 205 (synonymy; description; Java).—A. H. CLARK, Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 245 (identity); Crinoids of the Indian Ocean, 1912, p. 30 (same).

Antedon philiberti P. H. CARPENTER, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*).—BELL, Proc. Zool. Soc. London, 1882, p. 533 (listed).—P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 513 (compared with *Antedon bipartipinna* [*Craspedometra acuticirra*]); Proc. Zool. Soc. London, 1882 (1883), pp. 743 ff. (discussion of Bell's method of formulation and corrected formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 55, 253, 366, 380 (discussion).—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 19 (in key).—MINCKERT, Archiv für Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 228 (regeneration).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 35, 110 (identity of records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 86 (same).

Himerometra philiberti A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed).

Amphimetra mortenseni A. H. Clark, Proc. U. S. Nat. Mus., vol. 36, 1909, p. 635 (description; Port Blair, Andamans); Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 250 (synonym of *philiberti*); Crinoids of the Indian Ocean, 1912, p. 107 (same); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 77, footnote 2 (same).

Amphimetra philiberti A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 21 (nearest relative of *Amphimetra* [*Heterometra*] *africana;* differential characters); Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 245 (=*Comatula philiberti* J. Müller), p. 250 (Java; detailed description of the type; includes *mortenseni*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 13 (Kwala Cassan, Malay peninsula; description of specimens), pp. 14, 15 (compared with *Amphimetra schlegelii*); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 393 (compared with *Amphimetra* [*Heterometra*] *africana*); Crinoids of the Indian Ocean, 1912, pp. 30, 35 (identity), p. 107 (synonymy; detailed description; localities; notes on the type specimen), p. 316 (Andamans), fig. 7, p. 108.

Heterometra philiberti A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 77 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 28.

Diagnostic features.—The very short discoidal brachials in the outer half of the arms combined with the presence of IIIBr series all, most, or at least some of which are 4(3+4), and the more or less swollen elements of the division series and earlier brachials easily distinguish this species.

The cirri have 26–45 (usually about 35) segments of which the longest are nearly as long as broad. There are 18–27 arms 80–150 mm. long.

Description.—The centrodorsal is thick discoidal, with the bare polar area flat, 4 or 5 mm. in diameter. The cirrus sockets are arranged in two closely crowded alternating marginal rows.

The cirri are XVIII–XX, 30–42 (usually about 35), 25 to 30 mm. long. The first segment is short, about three times as broad as long, the second and third are about twice as broad as long, and those following gradually increase in length to the ninth or tenth, which is nearly, though never quite, as long as broad. The next five or seven segments are similar; those following gradually decrease in length so that those in almost the whole of the terminal half of the cirri are about half again as broad as long. From the twelfth or fourteenth segment onward sharp median tubercles or small spines are developed on the dorsal side, those on the last few segments occupying a position slightly proximal to median. The opposing spine is much larger than the processes on the preceding segments, triangular, the apex median, arising from very nearly the whole dorsal surface of the penultimate segment, equal to about half the width of that segment in height. The terminal claw is longer than the penultimate segment, moderately stout basally, but gradually becoming slender distally, and is moderately curved.

The radials are concealed, or just visible beyond the rim of the centrodorsal. The IBr_1 are oblong, very short, in close lateral apposition. The IBr_2 (axillaries) are very broadly pentagonal, almost triangular, the lateral edges not quite so long as those of the IBr_1, about two and one-half times as broad as long. The IIBr series are 4(3+4). The IIIBr series are 4(3+4). The division series and first two brachials are in close lateral apposition and laterally flattened against their neighbors, the dorsal carination of P_D only being visible exteriorly between them; synarthrial tubercles are usually prominent.

The 20–25 arms are 150 mm. long. The first brachial is slightly wedge-shaped, short, about three times as broad as its exterior length, almost entirely united interiorly. The second is of about the same size, but more pronouncedly wedge-shaped. The first syzygial pair (composed of brachials 3+4) is oblong, half again as broad as long. The next five or six brachials are oblong, nearly or quite four times as broad as long, and those following slowly become wedge-shaped and later almost triangular, four times as broad as long, soon becoming wedge-shaped again and, in the distal half of the arm, oblong and very short, though somewhat longer again terminally. The proximal discoidal brachials are somewhat swollen, and most of the brachials have slightly overlapping distal ends.

Syzygies occur between brachials 3+4, again from between brachials 13+14 to between brachials 31+32 (usually somewhere between the sixteenth and twenty-fifth, with sometimes an extra one from two to four or five brachials beyond the first), and distally at intervals of 2 to 13 (usually 8 to 12) muscular articulations.

P_D is 7 mm. long, moderately stout basally but tapering rapidly and becoming slender in its distal half, with about 25 segments, which at first are three times as broad as long, becoming twice as broad as long at the sixth, and squarish in the terminal portion; some of the lower segments are bluntly carinate. P_1 is 10 mm. long with 30 segments, slightly less stout basally than P_D and tapering somewhat less rapidly; the segments are at first about twice as broad as long, becoming as long as broad on about the eighth, and somewhat longer than broad terminally. P_2 is 15 mm. long, stouter than P_1, tapering evenly to a delicate tip, with 30 segments which at first are about half again as broad as long, become squarish on the eighth or ninth, and are about twice as long as broad at the tip. P_3 is 22 mm. long, stouter than the preceding, with 30 segments, which at first are broader than long, becoming squarish on the tenth, and longer than broad terminally; the pinnule is more or less carinate in its proximal half, and has a moderately developed supplementary ridge on the distal half of the outer side. P_4 resembles P_3 but is very slightly longer and proportionately stouter and more carinate. P_5 is like P_3. P_6 is 10 mm. long, resembling P_1 but somewhat more strongly carinate proximally. The following pinnules gradually decrease to 7 mm. in length and lose the basal carination, then increase to 12 mm. distally. On some arms P_5 is small as described for P_6, and again P_4 may also be small, while occasionally P_2 and P_4 are similar, and P_3 is greatly enlarged; sometimes P_2, P_3 and P_4 are as described for P_3, P_4 and P_5. On one or more of the inner arms of each ray P_3 is often much larger than on the outer, while the adjacent pinnules are reduced in size.

Notes.—The preceding description was taken from the specimen from Port Blair, Andaman Islands, which served as the type of *Amphimetra mortenseni.*

The six specimens from Kwala Cassan are all rather smaller than those from the Andaman Islands and apparently are not quite fully grown.

One has 24 arms 100 mm. long. One of the IIIBr series is 2, all the other division series beyond the IBr series being 4(3+4). The cirri have 32–33 segments, of which the longest are very nearly as long as broad.

Another specimen has 22 arms 100 mm. long. Four of the IIBr series and two of the IIIBr series are 2, the IIIBr 2 series being both internally developed. The cirri have 33–34 segments.

A third specimen has 22 arms 95 mm. long. Both the IIIBr series, one externally and one internally developed, are 2, all the other division series beyond the IBr series being 4(3+4). The cirri are XXIII, 29–33, 23 mm. long.

A fourth specimen has 27 arms 90 mm. long. Of the IIBr series one is 2 and the rest are 4(3+4). Six of the IIIBr series are 2, only one being 4(3+4). The cirri have 26–29 segments.

A fifth example has 18 arms 85 mm. long. One postradial series bears two undivided arms. The 8 IIBr series present are 4(3+4). The cirri have 27–28 segments. One cirrus has the distal half regenerated.

The sixth specimen has 21 arms 80 mm. long. One of the IIBr series is 2, the other 9, the single IIIBr series being 4(3+4). The cirri have 26–30 segments of which the longest are nearly as long as broad.

The specimen from Java was described by Prof. Johannes Müller in the following terms: The centrodorsal is flat in the middle and bears about its margin a row of cirri. The cirri have 45 segments which are not longer than broad and of which the greater part, except those at the base, bear a swollen process. There are three radials (that is, there is one radial and the two elements of the IBr series); the radial axillary is without a syzygy (that is, the elements of the IBr series are united by synarthry). The IIBr series are 4(3+4), the second element resting obliquely on the first. There are sometimes present IIIBr 4(3+4) series. The second element of the IIIBr series and the second brachial of the free undivided arms lie obliquely on the ossicle preceding, as in the case of the second element of the IIBr series. There are 26 arms. The brachials following the second are very short. The two first pinnules are small, the two following are larger, and those succeeding become smaller.

I examined Müller's type specimen at the Paris Museum in 1910 and found it to represent the form I had described in 1909 as *Amphimetra mortenseni*. The cirri are XXIII, 38–44. There are 25 arms. The 10 IIBr series are 4(3+4). Of the five IIIBr series present, four are 4(3+4) and one is 2. The lateral borders of the division series are produced into a lateral shelf. The synarthrial tubercles are small, but prominent, as in the type specimen of *Amphimetra discoidea* from Port Molle. The brachials are very short, with their distal borders slightly produced. P_D is very small and weak. P_1 is a little larger than P_D, and P_2 is sometimes a little larger than P_1 or sometimes very much larger than P_1 and resembling P_3. P_3 is the largest pinnule, long, rather stout, and composed of 26 segments of which the majority are about as long as broad. P_4 resembles P_3 and reaches almost the same size, or is a little shorter than P_2. The following pinnules are short. P_3 is stouter, longer, and more stiffened than is usually the case in related species.

Localities.—Investigator; Port Blair, Andaman Islands [A. H. Clark, 1909, 1911, 1912, 1918] (1, I. M.)

Investigator; Andaman Islands [A. H. Clark, 1912] (5, U. S. N. M., 35176, 35190, 35203, 35219, 36240, 36241; I.M.).

Kwala Cassan, Malay Peninsula; Ed. L. Mayer [A. H. Clark, 1912] (6, H. M.).

Java; M. Philibert [J. Müller, 1849; Dujardin and Hupé, 1862; P. H. Carpenter, 1879, 1882, 1883, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1913, 1918] (1, P. M.).

Geographical range.—From the Andaman Islands to the Malay Peninsula and Java.

Bathymetrical range.—Littoral.

History.—This species was first described under the name of *Comatula philiberti* by Prof. Johannes Müller in 1849 from a specimen from Java collected by M. Philibert which he had personally studied in the Paris Museum. The original description was translated and republished by Dujardin and Hupé in 1862.

In 1879 Dr. P. H. Carpenter referred this species to the genus *Antedon,* and in 1882 he compared it with his new *Antedon bipartipinna* (=*Craspedometra acuticirra*) to which he believed it to be closely related.

Prof. F. Jeffrey Bell in 1882 published a specific formula for this form, and early in the following year Carpenter published a corrected and emended formula.

As this species was not among the comatulids secured by the *Challenger,* Carpenter did not discuss it in detail in the *Challenger* report. He merely inserted it in the key to the species of the *Savignyi* group in which it was paired with *Antedon bipartipinna,* these two species being distinguished in the key from all the other species of this group by having the IIIBr series 4(3+4). Under this common heading he characterized *philiberti* as having 45 cirrus segments, the later ones short and spiny, whereas in *bipartipinna* there are nearly 60 cirrus segments of which the later are longer than broad and quite smooth.

Dr. Clemens Hartlaub in his key to the species of the *Savignyi* group published in 1891 put *bipartipinna* with (*Himerometra*) *crassipinna* under a section characterized by having the IIIBr series both 2 and 4(3+4), while *philiberti* was placed alone in a section characterized by having the IIIBr series all 4(3+4).

In my first revision of the genus *Antedon* published in 1907 I assigned *philiberti* to the new genus *Himerometra,* and in my revision of the family Himerometridae published in 1909 I retained *philiberti* in *Himerometra,* though with a query.

Having received for study the extensive collections assembled by the Royal Indian Marine Surveying steamer *Investigator,* I found among them a specimen from Port Blair in the Andaman Islands that seemed to represent a very distinct new species, quite different from any form with which I was personally acquainted. This I described in 1909 under the name of *Amphimetra mortenseni.*

In the following year I visited Paris and there examined Müller's type specimen of *philiberti.* I saw at once that it represented the same species as my recently described *Amphimetra mortenseni.* In 1911 I published notes on this specimen, using the name *Amphimetra philiberti,* and said that my *A. mortenseni* was a synonym of this species.

In my monograph on the crinoids of the Indian Ocean published in 1912 I republished my description of *Amphimetra mortenseni* under the heading *Amphimetra philiberti,* and figured a typical specimen of the former. I recorded four additional specimens from the Andaman Islands in the main portion of this work and another in the appendix, and mentioned Java and Kwala Cassan as the other localities from which it is known.

In the same year I recorded and gave notes upon six specimens from Kwala Cassan in the Malay Peninsula that I had found in the Hamburg Museum.

In my report published in 1918 upon the unstalked crinoids collected by the *Siboga* expedition, *philiberti* is included in the key to the species of *Heterometra*, and in a footnote I said that this species includes *Amphimetra mortenseni* A. H. Clark, 1909. As the species was not collected by the *Siboga* it is not mentioned further.

HETEROMETRA SARAE, sp. nov.

Diagnostic features.—There are no IIIBr series. The brachials are exceedingly short, and those in the proximal portion of the arms have the dorsal surface swollen. The cirri are 20–30 mm. long and are composed of 25–33 (usually 30–33) segments of which the longest are about as long as broad and the outer are slightly broader than long and bear a small carinate dorsal spine. The 19 arms are 145 mm. long. The carination on the earlier segments of the enlarged proximal pinnules is almost obsolete.

Description.—The centrodorsal is discoidal with the bare dorsal pole flat, 5 mm. in diameter. The cirrus sockets are arranged in one and a partial second marginal row.

The cirri are XII, 25–33 (usually 30–33), from 20 to 30 mm. long. The first segment is short and those following slowly increase in length, becoming nearly or quite as long as broad on the eighth; the succeeding segments are subequal, distinctly, but not greatly, broader than long. On the sixth-ninth and one or two following segments there is a small sharp dorsal tubercle situated in the median line just beyond the middle of the segment; this almost immediately becomes a blunt or sharp small carinate spine with the apex subterminal, on the outermost segments moving to median. The opposing spine is conical, erect, in height equal to about half the width of the penultimate segment. The terminal claw is short, scarcely or not at all exceeding the penultimate segment in length, stout, and strongly curved.

The radials are concealed, or are visible as a thin finely beaded line just above the rim of the centrodorsal. The IBr_1 are exceedingly short, 8 or 10 times as broad as long, with the proximal and distal edges parallel and the lateral borders in close apposition with those of their neighbors on either side. The IBr_2 (axillaries) are exceedingly short, three and one-half or four times as broad as long, triangular with the lateral angles acute or slightly truncated and the distal edges almost straight. Of the nine IIBr series present, seven are 4 (3+4) and two are 2. The division series are broad, in lateral apposition and laterally flattened, and are composed of unusually short segments, the terminal syzygial pair being twice as broad as long or even broader.

The 19 arms are 145 mm. long. The brachials from the first are extremely short; up to the ninth they have parallel ends, the ends then becoming slightly oblique, and at the end of the proximal quarter of the arm practically parallel again. The earlier brachials have a somewhat swollen dorsal surface, and beyond the basal quarter somewhat prominent, though unmodified, distal ends.

P_1 is 8 mm. long, small and weak, with 26 segments. It tapers rather rapidly in the first six segments and beyond this is delicate and flagellate. The first segment is about two and one-half times as broad as long and those following gradually increase in length to the eighth which, with most of those succeeding, is about as long as broad. P_2 is 15–18 mm. long, stout, tapering very slowly to the tip, and stiffened, with 25 segments, which become as long as broad on the sixth and twice as long as broad terminally. The outer surface of the pinnule from about the sixth segment onward is sharpened or gabled in the median line, and there is a slight sharpening of the distal border of the basal segments. P_3 resembles P_2 but is longer and noticeably stouter, especially in the outer half. P_4 may resemble P_3 or it may be shorter and more rapidly tapering than P_2. P_5 is 11 mm. long, with 22 segments, tapering rather rapidly in the proximal half, with the distal half slender and delicate. The following pinnules resemble P_5. The proximal segments of the proximal and middle pinnules are not carinate; at most they are slightly gabled or sharpened on the distal border.

Locality.—Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Amboina; about 2 meters; February 9, 1922 (1, C. M.).

Remarks.—This species seems to be very distinct from any previously described, the entirely smooth, enlarged, and much stiffened proximal pinnules, the very slight carination on the basal segments of the lower pinnules, and the exceedingly short elements of the division series and brachials distinguishing it at once.

HETEROMETRA PARILIS (A. H. Clark)

PLATE 35, FIGURES 157–160

[See also vol. 1, pt. 2, fig. 796 (ambulacral deposits), p. 372.]

Himerometra bengalensis A. H. CLARK, Smithsonian Misc. Coll., vol. 52, 1908, p. 214 (*Albatross* station 5146).

Amphimetra parilis A. H. CLARK, Proc. U. S. Nat. Mus., vol. 37, 1909, p. 32 (description; *Albatross* station 5147); Crinoids of the Indian Ocean, 1912, p. 112 (synonymy; locality); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 82 (in key; range), p. 84 (references; localities from which known).

Heterometra bengalensis A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 130 (in part; Philippines); Monograph of the existing crinoids, vol. 1, pt. 2, 1921, p. 240, fig. 796, p. 372 (ambulacral deposits); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 21 (ambulacral deposits; figure from preceding).

Diagnostic features.—There are no IIIBr series. The brachials are exceedingly short, and those in the proximal portion of the arm have the proximal end elevated so that the profile of the earlier portion of the arm is regularly serrate with the teeth directed proximally. The profile of the outer two-thirds of the arms is smooth. The cirri are 25–30 mm. long and are composed of 30–33 segments, of which the longest are nearly as long as broad and the outer are about twice as broad as long with prominent median dorsal spines. The 10–16 arms are 100–150 mm. long. The carination on the earlier segments of the lower pinnules is strongly marked, though not exaggerated.

Description.—The centrodorsal is thick discoidal with the bare polar area flat 2.5 mm. in diameter. The cirrus sockets are arranged in one and a partial second crowded and irregular marginal rows.

The cirri are XII, 30–33, 25 to 30 mm. long, moderately stout. The segments are subequal in length, all broader than long. They are at first very short, slowly increasing in length to the seventh or eighth, which, with the three or four following, is about half again as broad as long, then very slowly decreasing so that the segments in the distal half of the cirri are about twice as broad as long. The twelfth and following segments have prominent median dorsal spines which are directed distally.

The opposing spine is longer than the spines on the preceding segments, sharp, triangular in profile, rather slender, with the apex median; it reaches a length about equal to half the width of the penultimate segment. The terminal claw is longer than the penultimate segment, slender, more strongly curved proximally than distally.

The radials are just visible in the midradial line beyond the rim of the centrodorsal and form low triangles in the interradial angles of the calyx; their anterolateral corners are slightly swollen. The IBr_1 are oblong, four times as broad as long, and almost entirely united laterally. The IBr_2 (axillaries) are almost or quite triangular, somewhat over twice as broad as long, in lateral apposition with their neighbors and laterally flattened.

The 10 arms are 150 mm. long and taper rather more gradually than those of *A. discoidea*. The first two brachials are short, wedge-shaped, the second slightly the longer exteriorly but tapering almost to a point interiorly, the first entirely united interiorly. The first syzygial pair (composed of brachials 3+4) is oblong, two and one-half or three times as broad as long. The next seven or eight brachials are oblong, very short, about four times as broad as long or even shorter, those succeeding becoming wedge-shaped, about the same length, and in the distal half of the arm oblong and very short. In the proximal third of the arm the proximal edge of the brachials is somewhat raised, but the remainder of the arm is perfectly smooth.

Syzygies occur between brachials 3+4, again between brachials 9+10 (this sometimes omitted) and 14+15 or 15+16, and thence at intervals of 7 to 17 muscular articulations up to about the middle of the arm, beyond which point syzygies are rare or entirely lacking.

P_1 is 9 mm. long, broad basally but tapering rapidly and becoming slender and flagellate in the distal half, composed of 30 segments, of which the first eight are broader than long, very considerably so at first, and the remainder are about as long as broad. P_2 is 13 mm. long, stout like P_1 in the basal third but tapering rapidly and becoming slender and flagellate distally, with 30 segments, of which the first six are broader than long and the remainder are about as long as broad. The broad lower segments, like those of P_1, are carinate. P_3 is 19 mm. long, much stouter than P_1 or P_2 but of the same general form, stout basally but becoming gradually slender distally with a flagellate tip; it is composed of 30 segments. P_4 is 20 mm. long, stouter and stiffer than P_3 with about 25 segments, of which the first 10 are broader than long and those following are about as long as broad becoming slightly longer than broad distally. Like P_3, P_4 is carinate in its basal half and has a low lateral keel in its outer two-thirds. P_5 is 10 mm. long, about as stout basally as P_2 but not tapering so rapidly, with 17 segments, of which the first six are longer than broad and the remainder are about as long as broad; the first seven segments are strongly carinate. P_6 and the following pinnules are 7 mm. long, with 16 segments, slender, about as stout as P_1 proximally but not tapering so rapidly, the first five or six segments broader than long and strongly carinate, those following about as long as broad, and finally slightly longer than broad. The distal pinnules are 10 mm. long and moderately slender. The carination of the basal pinnule segments gradually dies away at the end of the proximal fourth of the arm.

Notes.—The specimen from *Albatross* station 5146 has 16 arms 100 mm. long. Of the six IIBr series present, five are 4(3+4) and one is 2. The brachials in the proximal fourth of the arms have produced proximal ends that overlap the distal ends of the preceding brachials; the brachials beyond the proximal fourth of the arms are entirely smooth, joining perfectly end to end.

Remarks.—This species is very close to *H. sarae* from which it differs in lacking the strongly swollen dorsal surface of the ossicles of the division series and brachials, in having much shorter distal cirrus segments, and in having the earlier segments of the lower pinnules conspicuously carinate.

Localities.—*Albatross* station 5147; Sulu (Jolo) Archipelago, in the vicinity of Siasi; Sulade Island (E.) bearing N. 3° E., 8.4 miles distant (lat. 5°41′40″ N., long. 120°47′10″ E.); 38 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1909, 1912, 1918] (1, U.S.N.M., 25515).

Albatross station 5146; Sulu (Jolo) Archipelago, in the vicinity of Siasi; Sulade Island (E.) bearing N. 18° W., 3.4 miles distant (lat. 5°46′40″ N., long. 120°48′50″ E.); 44 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1908, 1912, 1918] (1, U.S.N.M., 35089).

History.—The first known specimen of this species was recorded by me without comment in 1908 under the name of *Himerometra bengalensis* from *Albatross* station 5146. In the following year a 10-armed specimen from station 5147 was described as a new species under the name of *Amphimetra parilis.*

The first specimen served as the basis for the inclusion of the Philippines in the range of *Heterometra bengalensis* in my monograph of the crinoids of the Indian Ocean published in 1912, and the description and figure of the ambulacral deposits of *H. bengalensis* in Part 2 of the present work were likewise based upon it. But the error in determination was discovered before the report on the unstalked crinoids of the *Siboga* expedition was published (1918), although at that time the specimen was not redetermined.

In the monograph of the crinoids of the Indian Ocean (1912), *Amphimetra parilis* was simply listed as a distinct species; but in the report on the *Siboga* crinoids (1918) one of the two specimens included by Grube in his *Comatula laevissima* was included under *A. parilis* as a questionable synonym (see pages 349 and 353).

HETEROMETRA BENGALENSIS (Hartlaub)

PLATE 30, FIGURES 127–130

[See also vol. 1, pt. 2, figs. 457–462 (pinnule tips), p. 266.]

Antedon bengalensis HARTLAUB, Nachr. Ges. Göttingen, May 1890, p. 182 (description; Bay of Bengal); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 17 (in key), p. 19 (detailed description and comparisons; Bay of Bengal), p. 113 (in Göttingen Mus.), pl. 1, fig. 2, pl. 2, fig. 16.—HERDMAN, Ceylon Pearl Oyster Rep., vol. 5, Suppl. Rep. 41, 1906, p. 449 (redetermination of Chadwick's *A. anceps*).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 36 (identity).

Antedon anceps CHADWICK, Rep. Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon), p. 157 (stations XXIV and LVII).—HERDMAN, Ceylon Pearl Oyster Rep., vol. 5, Suppl. Rep. 41, 1906, p. 449 (correction of preceding record).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 40 (same).

Himerometra bengolensis A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Heterometra bengalensis A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 11 (listed); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 440 (in part; Australian specimens are *Zygometra punctata*); Mem. Australian Mus., vol. 4, 1911, p. 722 (same); Crinoids of the

Indian Ocean, 1912, p. 36 (identity), p. 40 (includes *anceps* of Chadwick, 1904), p. 130 (Bay of Bengal [from Hartlaub] and Ceylon [from Chadwick]; Philippines [=*H. parilis*]; specimens recorded are *H. reynaudi*; records from Queensland and Holothuria Bank refer to *Zygometra punctata*), p. 318 (specimens recorded are all *H. reynaudi*), fig. 12, p. 131, is *H. reynaudi*; Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 310 (all Australian records refer to *Zygometra punctata*), pp. 313, 314 (same).—H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 93 (occurs at Ceylon).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 79 (characters given in the key, and "eastern coast of India" refer to *H. reynaudi*); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 21 (ambulacral deposits).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 23.

Heterometra aspera A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 162 (description; Singapore), p. 193 (collected at Singapore by Svend Gad); Crinoids of the Indian Ocean, 1912, p. 128 (synonymy; Singapore); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 79 (in key; range); A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, No. 249, 1929, p. 638 (Singapore; 7 fathoms); Proc. Biol. Soc. Washington, vol. 47, 1934, p. 11 (Singapore).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.

Diagnostic features.—The brachials beyond the proximal fourth of the arms are exceedingly short, discoidal, with the ends parallel, and the distal ends of the lower brachials are produced and more or less strongly everted. There are no IIIBr series. The cirri are 13–22 mm. long, with 22–31 (rarely so many as 30) segments of which the longest are somewhat longer than broad. The 11–18 arms are 50–100 mm. long. P_2 and P_3 are similar, 9 mm. long with 24 segments, or P_3 is somewhat smaller than P_2.

Description.—The centrodorsal is a rather large convex disk with inwardly sloping sides; the convex bare dorsal pole is sculptured with small pits. The cirri are arranged in one and a partial second marginal rows.

The cirri are XVII, 22–24, about 13 mm. long. The fifth-eighth segments are somewhat longer than broad, and the outer are slightly compressed laterally, from the ninth onward bearing a well developed spine.

The radials are partially visible. The IBr_1 are short and broad, laterally either free or partially united. The IBr_2 (axillaries) are short, broad, and 5-sided. One IIBr 4(3+4) series is present. The division series have flattened sides from the IBr_1 to the second brachial. They are bordered by low shelves which are somewhat produced and are sharply set off from the rounded dorsal part of the segments.

The 11 arms are apparently 50 mm. long. They have a bluntly serrate dorsal profile. The brachials are very short. The first eight brachials, the first syzygial pair not excepted, are as short as those following. They have, especially the second, alternating slight lateral overlappings at the distal end. The following brachials are wedge-shaped with somewhat produced distal borders, those succeeding later becoming more discoidal and remaining short to the tips of the arms.

Syzygies occur between brachials 3+4, again between brachials 9+10 or 10+11, and distally at intervals of 3 to 6 (usually 4) muscular articulations. Toward the ends of the arms the intersyzygial interval becomes somewhat larger. In arms arising from a IIBr axillary the second syzygy is about brachials 16+17, and the intersyzygial interval is 8 to 10 muscular articulations.

The lower pinnules are rather stiff. P_D, and on the arms arising from a IBr axillary P_1, is short and is composed of about 20 segments. P_2 and P_b are of about equal length, 7 mm. long. The following pinnules decrease gradually in length to those of the sixth pair, which are the shortest. From this point they increase rapidly in size up to their final length of about 5 mm. P_1, P_2, and P_3 are somewhat longer than the corresponding pinnules (P_a, P_b, and P_c) on the inner side of the arm. The proximal segments of all these pinnules are short and broad, and in the eight or nine first pairs are prominently and sharply keeled.

The disk is 8 mm. in diameter and is deeply incised. The sacculi are large and crowded on the pinnules, forming two very irregular rows. They are not found on the disk.

The centrodorsal and cirri are white, the arms are flesh colored with chocolate-brown bands between the brachials, and the disk is light gray-brown.

The preceding description is adapted from Hartlaub's description of the type specimen in the Göttingen Museum.

Notes.—The two specimens collected during the course of the Ceylon Pearl Oyster Fisheries investigations, one at station LVII and the other at station XXIV, both have 11 arms, a single IIBr 4(3+4) series being present in each. The color when living was black.

The type specimens of *H. aspera* from Singapore may be thus described: The centrodorsal is moderately thick, discoidal, with the bare polar area slightly convex, 3 mm. in diameter, and having a more or less pitted surface. The cirri are XVII, 26–31, from 17 mm. to 22 mm. in length, and moderately slender. The first segment is short and those following gradually increase in length to the fifth or seventh, which is about as long as broad. The succeeding segments are similar, or slightly longer than broad, after about the twelfth or thirteenth, which is a more or less marked transition segment, decreasing in length, soon becoming as long as broad and so continuing to the end. The segments beyond the transition segment have moderate sized blunt dorsal spines. The opposing spine is much larger than the spines on the preceding segments. The radials are almost entirely concealed by the centrodorsal. The IBr_1 are short and bandlike. The IBr_2 (axillaries) are almost triangular, two to two and one-half times as broad as long. The IIBr series are 4(3+4). The division series as far as the base of P_D are in close apposition and laterally flattened against each other. The synarthrial tubercles are rather prominent. The arms are 14–18 in number, 60 mm. long. The brachials are very short with, except for the first few discoidal brachials, strongly produced distal ends.

P_D is 7 mm. long, moderately stout basally but tapering rapidly in its proximal half and becoming slender and flagellate distally. It is composed of 24 segments, which are at first twice as broad as long or even broader but become as long as broad distally. The larger proximal segments are strongly carinate. P_1 is similar to P_D, of the same length or slightly longer, and of the same size basally but tapering somewhat less rapidly. P_2 and P_3 are the same length, 9 mm. long, about as stout as P_1 basally but tapering much more gradually and hence appearing larger, and somewhat stiffened. They consist of 24 segments which at first are broad, becoming about as long as broad at about the middle of the pinnule, and elongate distally; the proximal segments are strongly carinate. P_4 is of the same character as the pinnules preceding but is smaller, only 6 mm. in length. P_5 is slender, small, and weak, 3 mm. long. The following pinnules very slowly increase in length, reaching 5 mm. distally. The color in alcohol is dark brown.

Of 16 young specimens from Singapore one has 17 arms 43 mm. long; two have 14 arms 55 mm. long; four have 13 arms 45 to 50 mm. long; five have 12 arms 45 to 65 mm. long; and four have 11 arms 50 to 60 mm. long. In some of these the distal edge of the radials is bordered with a row of small regular tubercles, and the lateral and proximal edges of the IBr_1 may be more or less scalloped.

Localities.—Gulf of Manaar; Ceylon Pearl Oyster Fisheries station LVII; outside Dutch Moderagam Paar; 21–66 meters; bottom orbitolites sand, nullipores, and dead corals [Chadwick, 1904; Herdman, 1906; A. H. Clark, 1912, 1918; H. L. Clark, 1915].

Off Trincomalee (Trinquemale), Ceylon; Ceylon Pearl Oyster Fisheries station XXIV; 2.5 to 3 miles north of Foul Point; 44–84 meters; bottom hard and rough—probably rock [Chadwick, 1904; Herdman, 1906; A. H. Clark, 1912, 1918; H. L. Clark, 1915].

Bay of Bengal [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1912, 1918].

Singapore; Svend Gad [A. H. Clark, 1909, 1912, 1918] (21, U.S.N.M., E.1073, E.1079; C.M.).

Singapore; 13 meters; December 12, 1898 [A. H. Clark, 1929] (2, B. M.).

New Harbour, Singapore; 15 meters; July 31, 1899 [A. H. Clark, 1934] (1, Raffles Mus.).

Geographical range.—From Ceylon and the Bay of Bengal eastward to Singapore.

Bathymetrical range.—From the shoreline down to 44 (?84) meters.

History.—This species was first described by Dr. Clemens Hartlaub from a specimen from the Bay of Bengal in the Göttingen Museum in 1890. It was redescribed and figured in 1891. Hartlaub said that it is perhaps most nearly related to *H. quinduplicava* (*anceps*), which also has only 10–14 arms. He distinguished *bengalensis* from *quinduplicava* by the following characters: In *bengalensis* there are only 22–24 cirrus segments as against 25–35 in *quinduplicava;* the outer cirrus segments are prominently spiny whereas in *quinduplicava* the outer cirrus segments have no dorsal spines; in *quinduplicava* more or less distinct synarthrial tubercles are present, whereas there are none in *bengalensis; bengalensis* is further distinguished by the flattened sides of the division series, and finally by the carination of the pinnule segments in the proximal portion of the arms.

In 1904 Herbert C. Chadwick, under the name of *Antedon anceps* (=*quinduplicava*), recorded specimens from Ceylon, where they had been found during the course of the Ceylon Pearl Oyster Fisheries investigations under the direction of the late Sir William A. Herdman In 1906 Professor Herdman published a note reidentifying the specimens recorded by Chadwick as *Antedon bengalensis.*

In 1907 I referred *bengalensis* to the new genus *Himerometra* and in 1908 recorded a specimen from *Albatross* station 5146 under the name of *Himerometra bengalensis.* This specimen in reality represents *Heterometra parilis.* In 1909 I referred this species to the new genus *Heterometra.*

In a memoir on the recent crinoids of Australia published in 1911, I recorded, under the name of *Heterometra bengalensis,* three small specimens from Port Curtis in the Australian Museum and a specimen from Holothuria bank in the British Museum. These four specimens are in reality *Zygometra punctata.* The same records were included in a memoir on the crinoids collected by the Hamburg Southwest Australian Expedition, also published in 1911.

In my monograph on the crinoids of the Indian Ocean published in 1912 I recorded and gave notes on specimens identified as *Heterometra bengalensis*, which had been collected by the Royal Indian Marine Surveying steamer *Investigator* south of Ceylon and in the Andaman Islands. These specimens really represent *H. reynaudi*. In the previously known localities given for this species, Queensland and Holothuria Bank refer to *Zygometra punctata*, and Philippines refers to *H. parilis*. In an appendix to this monograph additional specimens of *H. bengalensis* were recorded from off Gopalpore in 25–28 and 30–38 fathoms, and from "?India." These specimens all represent *H. reynaudi*.

In a supplement to my memoir on the crinoids of southwestern Australia, published in 1913, I transferred the Australian records for *H. bengalensis* to *Zygometra punctata*.

In 1915 Dr. Hubert Lyman Clark listed this species from Ceylon, referring to my memoir on the crinoids of the Indian Ocean (1912).

In the report on the unstalked crinoids of the *Siboga* expedition published in 1918, I inserted *H. bengalensis* in the key to the species of *Heterometra* and assigned the following characters to it—brachials longer [than those of *H. aspera*] with more oblique ends which overlap only very slightly, if at all; 11–15 arms. These characters were taken from small specimens of *H. reynaudi* which were misidentified as *bengalensis*. The range is said to be Ceylon and the eastern coast of India. Chadwick's specimens are the only ones known from Ceylon; all the others recorded from Ceylon, and all those recorded from the eastern coast of India are in reality *H. reynaudi*.

Heterometra aspera, described by me in 1909 from specimens collected at Singapore by the Danish consul at that port, Svend Gad, was admitted as a valid species in the memoirs on the crinoids of the Indian Ocean (1912) and on the *Siboga* collection (1918) and was again recorded from Singapore in 1929; it ssems not to differ in any tangible features from *H. bengalensis*.

HETEROMETRA AFRICANA (A. H. Clark)

PLATE 26, FIGURE 108; PLATE 27, FIGURES 111–116

Antedon savignyi P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 252, 380 (Kurrachee).

Amphimetra africana A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 8 (southeastern Africa), p. 20 (description; Bagamoyo; also Zanzibar and Waxin); vol. 43, 1912, p. 381 (cotype in the U. S. N. M.), p. 384 (original reference), p. 393 (locality); Crinoids of the Indian Ocean, 1912, p. 111 (synonymy; localities); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 24 (published reference to specimens in the B. M.; Zanzibar; Waxin; notes).—HARTMEYER, Mitt. Zool. Mus. Berlin, vol. 8, Heft 2, 1916, pp. 235, 237 (Bagamoyo, No. 4616 [type], 6380).

Actinometra sp. Brit. Mus., MS. A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 21 (Waxin); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 24 (Waxin).

Heterometra savignii A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 24 (Kurrachi); Crinoids of the Indian Ocean, 1912, p. 124 (Kurrachi; Straits of Ormuz; notes); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 27 (specimen from Kurrachi); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 76 (in key; range; Persian Gulf and Kurrachi).

Antedon ?milberti Brit. Mus., MS. A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 24 (Zanzibar).

Heterometra africana A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 77 (in key; range).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 48 (extends to the east coast of Africa).—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 100 (range), p. 104.—GISLÉN, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 12 (relation to var. *delagoae*).

Diagnostic features.—There are no IIIBr series. The brachials are very short, and those in the proximal portion of the arms are unmodified. The cirri are 20–23 mm. long with usually 30 segments, of which the longest are about as long as broad and the outer are one-third again as broad as long; the tenth or eleventh and following segments bear long and prominent dorsal spines which begin abruptly. The 19 arms are about 125 mm. long.

Description.—The centrodorsal is thin discoidal, broad, with the flat polar area 4 mm. in diameter. The cirrus sockets are arranged in a single more or less irregular closely crowded marginal row.

The cirri are XXIII, 29–32 (usually 30), 20–23 mm. in length. The first segment is short and the following gradually increase in length to the seventh or eighth, which is about as long as broad. The following segments are at first similar, after the eleventh or twelfth very gradually decreasing in length so that the terminal segments are about one-third again as broad as long. The tenth or eleventh (usually the latter) and following segments bear long and prominent dorsal spines which begin abruptly. The cirri do not taper distally.

The radials are entirely concealed by the centrodorsal. The IBr_1 are very short, bandlike, in apposition laterally. The IBr_2 (axillaries) are short, two and one-half times as broad as long, with the lateral borders, which are not so long as those of the IBr_1, in contact. The IIBr series are 4(3+4). In the type specimen eight IIBr series are present, and the other arms are broken off before the first syzygy. The division series and the first brachials are in close lateral apposition and are sharply flattened against their neighbors. The lateral borders of the elements of the division series are slightly produced. The synarthrial tubercles are obsolete.

The arms in the type specimen are 19 (?20) in number, apparently about 125 mm. in length. The first brachials are short, slightly wedge-shaped, twice as broad as long exteriorly, interiorly united. The second brachials are slightly larger and more obliquely wedge-shaped. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly and twice as broad as long interiorly. The next four or five brachials are oblong, three times as broad as long, those succeeding becoming obliquely wedge-shaped, twice as broad as long, then gradually less obliquely wedge-shaped, and after the end of the proximal half of the arms practically oblong and very short.

P_1 is 12.5 mm. long, slender, flagellate distally, with 29 segments, which at first are twice as broad as long, becoming about as long as broad on the eighth and nearly twice as long as broad terminally. The second and following segments bear a sharp carinate ridge with the crest parallel to the axis of the pinnule, which gradually becomes less marked, disappearing on the tenth segment. P_2 is 15 mm. long, considerably stouter than P_1 and not tapering so rapidly distally, with 25 segments, which at first are short, becoming about as long as broad on the eighth or tenth, and twice as long as broad terminally. From the fourth segment there runs outward on the outer side of the pinnule just distal to the mediodorsal line a prominent narrow ridge, which continues almost to the tip. There is a similar but less-marked ridge on P_1. The second and following segments are rather sharply, but not highly, carinate. P_3 is similar to P_2, of about the same size, or slightly shorter and smaller. P_4 is 7 mm. long, rather stout, though much smaller than P_3, tapering evenly to the tip, with

15 segments, which become about as long as broad on the eighth. The second-eighth segments are rather strongly carinate. P_5 is similar but more slender, 6 mm. long, with only the second-sixth segments carinate. The following pinnules gradually lose the basal carination, become more slender, and increase in length, reaching 8 mm. distally.

The color in alcohol is brownish purple.

Notes.—The preceding description was drawn up from the type specimen from Bagamoyo. The other four specimens from Bagamoyo are very young, with the arms about 20 mm. long and the cirri about 6 mm. in length. Two have 11 and two have 10 arms.

A specimen from Zanzibar has the cirri XVI, 25–27. It is smaller than the type specimen from Bagamoyo but is otherwise similar to it.

A specimen from Waxin has 23 arms 120 mm. long. The IIBr series are 4(3+4), and the IIIBr series are 2. The cirri are XX, 27; long sharp dorsal spines are developed from the tenth segment onward. When this specimen is compared directly with a specimen of *H. savignii* the cirri are seen to be more spiny, the spines first appearing nearer the base, and the proximal pinnules are seen to be larger.

Of the seven specimens from Kurrachi in the British Museum, one has 21, two have 20, one has 19, two have 18, and one has 17 arms. The largest has the arms 130 mm. long and the cirri 25 mm. in length. The specimen with 21 arms has three IIBr 2 series; two of these are on the same postradial series, one being followed by a single internal IIIBr 2 series. One of the specimens with 18 arms has a single IIIBr 2 series. In the remaining specimens the IIBr series are invariably 4(3+4).

The specimen from Kurrachi collected by the *Investigator* is medium sized; there are 26 cirrus segments of which the distal bear strong dorsal spines.

In the specimen from Kurrachi in the National Museum the cirri are XXIII, 28–30, about 20 mm. long. Dorsal spines are present from the tenth to thirteenth segment onward; they are rather smaller than usual. There are about 18 arms.

In one of the specimens from the Straits of Ormuz the centrodorsal is thin-discoidal with a broad flat finely roughened dorsal pole, the edge of which is abruptly elevated into a smooth rounded arch at the base of each cirrus. The cirrus sockets are arranged in two closely crowded alternating rows.

The cirri are XX, 28–34, from 20 to 25 mm. long, and rather slender. The longest proximal cirrus segments, the tenth-eleventh or -thirteenth, are from slightly longer than broad to slightly broader than long, and the distal segments are about half again as broad as long. Dorsal spines begin from the twelfth to the fifteenth segment. They are high and conspicuous; the first is slightly smaller than the second, which is as large as those following.

The nine IIBr series present are all 4(3+4). The division series are broad, moderately rounded dorsally, in lateral contact with sharply flattened sides, which are produced into a narrow coarsely and irregularly tubercular or rugose border which is abruptly distinct from the dorsal surface.

There are 19 arms about 110 mm. long. The brachials in the distal half of the arms are oblong and very short.

P_D is 7 mm. long, with 24 segments; these at first are twice as broad as long or even broader, gradually increasing in length and becoming about as long as broad on the seventh, and somewhat longer than broad distally. Most of the segments are about as long as broad. The second-fourth segments bear a high carinate process with the finely spinous crest parallel to the axis of the segment. On the third segment following this crest rapidly decreases in height. P_1 is 7.5 mm. long, with 24 segments, which at first are much broader than long, becoming about as long as broad on the seventh, and nearly three times as long as broad terminally. The second-fourth segments are carinate, as in P_D, though not so strongly. P_2 is 12 mm. long, with 23 segments, much stouter than the pinnules preceding, evenly and gradually tapering to a delicate tip. The first two segments are somewhat more than half again as broad as long; those following gradually increase in length becoming about as long as broad on the fifth and about three times as long as broad terminally. The second-fourth segments are rather narrowly carinate, the carinate process being highest on the second, less high on the third, and disappearing at the distal end of the fourth. P_3 is 6.5 mm. long, with 17 segments; it resembles P_2 but is proportionately smaller. P_4 is 5.3 mm. long, with 16 segments, and resembles P_3. P_5 is 5 mm. long, with 16 segments, resembling P_4 but less slender terminally and with the carinate processes on the second and third segments much higher. The pinnules following resemble P_5.

Another specimen has 18 arms 75 mm. long. A third has 13 arms 115 mm. long, IIBr 4(3+4) series being developed on three postradial series, and the cirri XIX, 31–33, 20 mm. long. A fourth has 12 arms 80 mm. long, and the cirri XVI, 25–28, 15 mm. long; of the two IIBr series present, one is 4(3+4) and the other is 2. A fifth has 12 arms 75 mm. long, and the cirri XX, 33–34, 20 mm. long; both IIBr series are on the same postradial series, and both are 4(3+4). The sixth specimen has 11 arms 65 mm. long; there is a single IIBr 4(3+4) series; the cirri are XV, 26–32, 15 mm. long. The last specimen has 10 arms 90 mm. long, and the cirri XVI, 26+, 20 mm. long.

Remarks.—This species seems to approach most nearly *H. philiberti*, but it is a smaller and less rugged form with fewer arms and much more spiny cirri.

Localities.—Bagamoyo (on the mainland of Africa opposite Zanzibar), Tanganyika Territory [A. H. Clark, 1911, 1912; Hartmeyer, 1916] (5, U.S.N.M., 35218; Berl. M., 6380 [4616]).

Zanzibar [A. H. Clark, 1911, 1912, 1913] (1, B.M.).

Waxin, south of Mombasa [A. H. Clark, 1911, 1912, 1913] (1, B.M.).

Kurrachi, Sind, northwestern India [P. H. Carpenter, 1888; A. H. Clark, 1911, 1912, 1913, all as *savignii*] (7, B.M.).

Kurrachi [A. H. Clark, 1912, as *savignii*] (1, U. S. N. M., 35189 [original No. 14F.]).

Investigator station 291; Straits of Ormuz, entrance to the Persian Gulf (lat. 26°22′ N., long. 56°10′ E.); 88–89 meters; muddy bottom; November 1, 1901 [A. H. Clark, 1912, as *savignii*] (7, U.S.N.M., 35180 [original No. ZEV 3095–7], 35761; I.M.).

Geographical range.—From Bagamoyo and Zanzibar to Waxin and from Kurrachi to the Persian Gulf.

Bathymetrical range.—From the shoreline down to 88 (?89) meters. Most of the records are from specimens collected along the shoreline.

History.—This species was first mentioned in 1888 by P. H. Carpenter who listed it under the name of *Antedon savignyi* as occurring at Kurrachee (Kurrachi).

It was first described by me under the name of *Amphimetra africana* in 1911 from a specimen from Bagamoyo in the Berlin Museum. At the same time two other specimens belonging to the British Museum, one from Zanzibar and one from Waxin (also spelled Wazin and Wasin), were recorded.

In a memoir on the crinoids in the Berlin Museum published in 1912 the type specimen was mentioned, and four smaller specimens collected with it were recorded.

In the memoir on the crinoids of the Indian Ocean published in 1912 I listed *Amphimetra africana* and gave as the habitat Bagamoyo, Zanzibar, and Wazin. Under *Heterometra savignii* I listed one specimen from Kurrachi and seven from the Straits of Ormuz and gave brief notes on them. Recent reexamination of these specimens has shown that they represent not *savignii* but the very different *africana*.

In my notes on the recent crinoids in the British Museum published in 1913, I briefly described the specimens of *Amphimetra africana* from Zanzibar and Waxin. Under *Heterometra savignii* I recorded and gave notes on seven specimens from Kurrachi. These were the specimens upon which Carpenter had based his record of Kurrachi for this species in the *Challenger* report. Of these specimens I said, "No differences could be detected between these specimens and those from the Gulf of Suez."

The only specimen from Kurrachi at hand certainly is not *savignii*, as is shown by the strongly carinate lower pinnules. It appears to represent *africana*. The brief notes given apply to *africana* better than they do to *savignii*, although the chief differential features—the strongly carinate lower pinnules and very short distal brachials of *africana*—are not mentioned. There is, of course, the possibility that Carpenter and I were correct in our determinations and that both *savignii* and *africana* occur at Kurrachi, but this is quite improbable.

In 1916 Dr. Robert Hartmeyer corrected the type numbers on the specimens of *Amphimetra africana* in the Berlin Museum.

In my report upon the unstalked crinoids of the *Siboga* Expedition published in 1918 I transferred *africana* from *Amphimetra*, under which genus it had been placed on account of its very short oblong distal brachials, to *Heterometra*, placing it in a key to the species of the latter genus where the range was given as "German Southeast Africa, Zanzibar, and British East Africa." In the same key the range of *H. savignii* was given as "Red Sea to the Persian Gulf and Kurrachi." The last two localities should have been placed under *africana*.

HETEROMETRA SCHLEGELII (A. H. Clark)

PLATE 39, FIGURES 180, 181

[See also vol. 1, pt. 2, fig. 192 (lateral view), p. 115].

Alecto schlegelii LÜTKEN, MS.

Himerometra schlegelii A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 223 (description; Japan [the 10-armed specimen is *Amphimetra laevipinna*]).

Amphimetra schegelii A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed).

Antedon schlegelii (Lütken, MS.) A. H. CLARK, Vid. Medd. Naturh. Foren. København, 1909, p. 117 (identity).

Amphimetra schlegelii A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 158 (Japan [one of the specimens is *Amphimetra laevipinna*]); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 14 (description of a specimen without locality; comparison with *philiberti*), p. 15 (original description based upon one specimen of *schlegelii* and one of *Amphimetra laevipinna*, but the former was selected as the type; northern representative of *philiberti*); Crinoids of the Indian Ocean, 1912, p. 111 (synonymy; Japan [records from New Guinea, Tonga and Fiji refer to *Amphimetra papuensis*]); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (Malayan species; range and its significance).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 28 (discussion).

Heterometra schlegelii A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 77 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 22, 48.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 12 (relation to *H. africana* var. *delagoae*).

Amphimetra schleegelii Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 28 (discussion).

Diagnostic features.—This is a small species without IIIBr series and with exceedingly short discoidal brachials in the outer half of the arms. The cirri are about 20 mm. long with usually 30–35 segments of which the longest are about as long as broad and the outer are about one-third again as broad as long; the twelfth and following bear long sharp dorsal spines. The 12–13 arms are 70–85 mm. long.

Description.—The centrodorsal is thick discoidal, with the polar area thickly covered with small low flattened tubercles. The cirrus sockets are arranged in two closely crowded alternating rows.

The cirri are XV, 26–35 (usually 30–35), about 20 mm. long. The first segment is short, the second is about twice as broad as long, the third is slightly longer, and the fourth is about as long as broad. The following to the twelfth or fourteenth are about as long as broad, some of the more proximal being occasionally slightly longer than broad, the length then very gradually diminishing so that the terminal segments are about one-third again as broad as long. From the twelfth segment onward comparatively long sharp dorsal spines are developed. The opposing spine is considerably longer than the spines on the few preceding segments; it is about equal to the width of the penultimate segment in length, and is rather slender, abruptly curved basally but becoming nearly straight in its distal half.

The radials project slightly beyond the rim of the centrodorsal. The IBr_1 are oblong, three or four times as broad as long, in close lateral apposition, and with the lateral edges swollen into a longitudinally elongate tubercle. The IIBr series are 4(3+4); there are three of these in the type specimen. The elements of the division series and the first two brachials are in close lateral apposition with their neighbors and are sharply flattened laterally.

The 13 arms in the type specimen are about 70 mm. long. The first brachials are short, slightly longer exteriorly than interiorly, interiorly united for about two-thirds of their length. The second brachials are somewhat larger and irregularly quadrate, rising to a rather prominent tubercle with the first which resembles the tubercle on the articulation between the elements of the IBr series. The first syzygial pair (composed of brachials 3+4) is oblong, about as long as the second brachials, three times as broad as long. The following six brachials are oblong, about three times as broad as long, those succeeding becoming wedge-shaped or almost triangular, then gradually oblong again and decreasing in length so that the brachials in the distal half of the arm are extremely short and discoidal, with projecting distal borders.

Syzygies occur between brachials 3+4 (in one case between brachials 4+5), again from between brachials 11+12 to between brachials 17+18, with occasionally an additional syzygy between brachials 9+10, and distally at intervals of 11–25 muscular articulations.

P_1 is about 5 mm. long, comparatively slender and tapering evenly from the base to the delicate tip, with about 18 segments, all of which are about as long as broad. P_2 is about 7.5 mm. in length, slightly stouter than P_1 but becoming slender and delicate distally, with about 18 segments of which the first two are not quite so long as broad, the next two are about as long as broad, and the following gradually become elongated and about twice as long as broad distally. P_3 is about 8 mm. long, stouter and stiffer than P_2, though the component segments are in the same number and of the same proportions. P_4 resembles P_3 but is shorter and somewhat less stout with about 12 segments of which the first two or three are not quite so long as broad and those following are about as long as broad, becoming rather longer than broad distally. Distally the pinnules slowly increase in length and become more slender. The distal pinnules are 6 mm. long, moderately slender, with about 20 segments of which the first is not so long as broad, the second is about as long as broad, and those following become gradually longer, reaching a length of about twice the breadth distally.

The color in alcohol is dull flesh color, with the perisome brown.

Notes.—A specimen without locality in the Hamburg Museum may be described as follows: The cirri are XV, 29–35, from 20 to 23 mm. long. The longer proximal segments are about as long as, or slightly longer than, broad. The distal segments are nearly twice as broad as their median length. The twelfth, thirteenth, or fourteenth and following segments bear a long and prominent, rather broad, dorsal spine. The segments that bear the dorsal spines have the dorsal surface flattened so that there is a rather conspicuous rounded ridge along the boundary between the lateral and dorsal surfaces. The radials have a finely beaded distal edge as is frequently the case in *H. philiberti*. The 12 arms are 85 mm. long. One postradial series bears a single IIBr 4(3+4) series, which carries internally a IIBr 2 series.

P_1 is small and slender, 6 mm. long, with 24 segments, which become about as long as broad on the fifth, the remainder being slightly longer than broad. The second-eighth bear a high broad finely spinous carinate process, which rapidly decreases in height after the third. P_2 is 10 mm. long, with 25 segments, of which the fifth-seventh are about as long as broad and the distal are twice as long as broad. The second-ninth are diminishingly carinate, the outer border of the carination being convex on the second but parallel to the longitudinal axis of the segment on the remainder. The pinnule is evenly tapering, and is proportionately larger than P_1. P_3 is 13 mm. long, with 24 segments. It resembles P_2, but the supplementary ridge is strongly indicated, and it becomes more distinctly prismatic distally. P_4 is 7 mm. long, with 18 segments, the second-fifth with carinate processes which are proportionately higher than those on the corresponding segments of the preceding pinnules. P_5 is 4.5 mm. long, with 14 segments, of which the second-fifth are very strongly and the sixth is somewhat carinate. The following pinnules resemble P_5. The distal pinnules are slender, 7 mm. long, with 19 segments of which the distal are about twice as long as broad.

Localities.—Japan [A. H. Clark, 1908, 1909, 1912, 1915, 1918; Gislén, 1919, 1924] (1, C. M.).

No locality; C. Eberstein [A. H. Clark, 1912, 1915, 1918] (1, H. M.).

History.—This species, which had long before received the manuscript name of *Alecto schlegelii* from Dr. Christian F. Lütken, was first described by me in 1908 under the name of *Himerometra schlegelii.* The description was based upon two specimens from Japan in the Copenhagen Museum that had been labeled *Alecto schlegelii* by Dr. Lütken.

On the establishment of the genus *Amphimetra* in 1909 *schlegelii* was transferred to it. Later in the same year the two original specimens were again mentioned. At that time I wrote that this species is most closely related to *Amphimetra ensifer* and, like that form, has the disk completely covered with a pavement of small plates. It may be distinguished at a glance, however, by the longer and much more prominent dorsal spines on the cirrus segments, and by the comparatively small size of the synarthrial tubercles.

In 1912 I described another specimen, which I had examined at the Hamburg Museum in 1910. I wrote that this species is closely related to *Amphimetra philiberti*, but it may easily be distinguished by the longer proximal cirrus segments, the longer and more prominent spines on the distal cirrus segments, and by the smaller number of arms. It is a considerably smaller and more delicate species than *A. philiberti.*

I said further that at the time I described *schlegelii* I had before me two specimens, one with 10 and the other with 13 arms, which were of the same size and general appearance. Such differences as I found between them I considered as probably the result of individual variation. At Hamburg there were also two specimens, one with 10 and the other with 12 arms, which resembled the pair in the Copenhagen Museum.

The presence in the collection of the Hamburg Museum of the type specimen of *laevipinna*, and of six specimens of *philiberti*, a species I had not seen when I described *schlegelii*, showed clearly that the 10-armed specimen at Copenhagen and the one at Hamburg are specifically identical with Carpenter's *laevipinna*, while the 12- and 13-armed specimens represent a very distinct form, easily differentiated by the strong carination of the pinnules, related to *philiberti.*

I remarked further that the specimen I selected as the type of *schlegelii* when I wrote the original description happened to be the one with 13 arms. Thus while the specimen with 10 arms, at first considered as identical with it, must be referred to *laevipinna*, the name *schlegelii* is available for the 13-armed specimen, and for the 12-armed example at Hamburg, which represents the same species.

In conclusion I said that *schlegelii* appears to be the northern representative of *philiberti*, just as *laevipinna* is the northern representative of the *discoidea* group of species—that is, of *Amphimetra* as now understood.

In my memoir on the crinoids of the Indian Ocean published in 1912 I listed *Amphimetra schlegelii* and gave as the range Japan and southward to New Guinea, Tonga, and Fiji. The last three localities refer to *Amphimetra papuensis* and are based on specimens from Port Moresby and Hood lagoon, New Guinea, in the Australian Museum, which were recorded in 1911 as *Amphimetra discoidea*, and others from

Tonga and Fiji in the British Museum, which were recorded in 1913 as *A. papuensis*.

In 1918 I transferred *schlegelii* from the genus *Amphimetra* to *Heterometra*, inserting it in a key to the species of the latter genus in the *Siboga* report.

Dr. Torsten Gislén said in 1919 that *Amphimetra schlegelii*, though nearly related to *A. milberti*, is probably a good species because of the large number of pinnulars combined with small arms. He had evidently overlooked my resolution of the species as originally described into its two components in 1912.

HETEROMETRA FLORA (A. H. Clark)

Antedon laevissima Bell, *in* Gardiner, Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. 1, pt. 3, 1902, p. 224 (Mulan, Maldives).

Amphimetra flora A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 23 (published reference to specimens in the B. M.; Mulan, Maldives; characters).

Heterometra flora A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 77 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 22.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 99 (range), p. 103.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 12 (relation to. *H. africana* var. *delagoae*).

Diagnostic features.—There are no IIIBr series. The brachials are very short and those in the proximal portion of the arms are unmodified. The cirri are stout and strongly curved, about 20 mm. in length, and are composed of 29–30 segments, all of which are much broader than long, the longest being about one-third again as broad as long. The 10–13 arms are 170–180 mm. long.

Description.—The cirri are about XV, 29–30, stout and strongly curved, about 20 mm. in length. All the segments are subequal, all broader than long, the longest being about one-third again as broad as long. The tenth or eleventh and following bear prominent and sharp dorsal spines.

The 10–13 arms are 170 to 180 mm. in length.

The longest proximal pinnules are about 20 mm. long and rather slender. The distal ends of their component segments are perfectly smooth. The basal segments are strongly carinate.

Notes.—In the type specimen the cirri are XV, 30. The 12 arms are 170 mm. long. Another specimen similar to the preceding has 10 arms 180 mm. long. A third specimen, rather smaller than the two others, has 13 arms. There are 29–30 cirrus segments, of which the tenth or eleventh and following bear dorsal spines. The proximal pinnules are rather more strongly carinate than they are in the other two.

Locality.—Mulan, Maldive Archipelago; J. Stanley Gardiner [Bell, 1902; A. H. Clark, 1913, 1918] (3, B. M.).

History.—The three known specimens of this species were first recorded under the name of *Antedon laevissima* by Prof. F. Jeffrey Bell in 1902. In 1913 I described this form as *Amphimetra flora*, transferring it to the genus *Heterometra* in 1918, when it was inserted in the key to the species of that genus in the *Siboga* report.

It was not mentioned in my memoir on the crinoids of the Indian Ocean published in 1912 for the reason that at the time the manuscript of that volume was completed I had come to no definite conclusion regarding its status.

HETEROMETRA DELAGOAE Gislén

Heterometra africana var. *delagoae* Gislén, Kungl. Svenska Vet. Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 4 (listed), p. 5 (characters), p. 10 (descriptions of specimens; *Pieter Faure* stations 1987, 2001, 2012, 2079, vicinity of Delagoa Bay), text figs. 8–11, p. 13, pl. 1, fig. 3.

Diagnostic features.—IIIBr series are present, usually 2; the brachials are very short, those beyond the proximal fourth of the arms being discoidal with parallel ends, and those in the proximal portion of the arms being unmodified. The cirri are moderately stout and moderately curved in the outer portion and are composed of about 30 segments, all of which are markedly broader than long. The 19–39 (most commonly about 30) arms are 75–85 mm. long.

Description.—The centrodorsal is flat, 4.5 mm. in diameter; the cirrus sockets are arranged in a partially double row.

The cirri are XXI–XXXII, 25–34 (usually about 30), 12 to 24 (usually about 20) mm. long. The longest proximal segments are one-third to one-half again as broad as long, and the distal segments are twice as broad as long. The distal segments are provided with long and sharp dorsal spines that begin abruptly on from the thirteenth to the sixteenth segment.

The IIBr series are usually 4 (3+4), sometimes 2, and the IIIBr series are usually 2, occasionally 4 (3+4), mostly internally developed.

The arms are 19–39 (most commonly about 30) in number, from 75 to 85 mm. long.

The first syzygy is between brachials 3+4, the second sometimes between brachials 5+6, or between brachials 9+10, and the third at about brachials 15+16. The distal intersyzygial interval is from 7 to 10 muscular articulations.

P_D is 7.5 mm. long, with 21 segments. P_1 is 9.5 mm. long, with 22 segments. P_2 is 12 mm. long, with about 24 segments. P_3 is of about the same length as P_2 but has fewer segments; on another specimen it is about 10 mm. long, with 20 segments. P_4 is shorter than P_3. The proximal pinnules are rather smooth, but angular in cross section, the proximal segments with a low double longitudinal carination which on the distal segments is replaced by a single one. From P_4 to about P_{10} there is a high crest running from the second to the fourth or sixth segment. This crest is interrupted at the articulations.

Notes.—In a specimen from station 2079, according to Gislén, the centrodorsal is flat, 4.5 mm. in diameter, and the cirrus sockets are arranged in a partially double row. The cirri are XXI, 29–34, from 18 to 22 mm. long. The longest proximal cirrus segments are half again as broad as long, and the distal segments are twice as broad as long. The distal segments are provided with long sharp dorsal spines, which begin abruptly on from the thirteenth to the sixteenth segment. The 19 arms are about 85 mm. long. Of the seven IIBr series present four are 4 (3+4), one is 2, and two are 5 (3+4). There are two IIIBr 2 series, both developed internally. The first syzygy is between brachials 3+4, the second between brachials 5+6, or sometimes between brachials 9+10, and the third at about brachials 15+16; the distal intersyzygial interval is 7 to 10 muscular articulations. P_D is 7.5 mm. long, with 21 segments. P_1 is 9.5 mm. long, with 22 segments. P_2 is 12 mm. long, with about 24 segments. P_3 is of about the same length as P_2 but has fewer segments. P_4 is shorter than P_3. The proximal pinnules are rather smooth but angular in section, with a low double longitudinal carination, which on the distal segments is replaced by a single one. From P_4 to about P_{10} there is a high crest running from the second to the fourth or sixth segment, which is interrupted at the articulations.

Eight specimens from *Pieter Faure* station 1987 show the following characters: (1) The arms are 6+4+6+4+4=24; (2) there are 6+5+4+6+4=25 arms; (3) The arms are 6+4+5+7+4=26; the ray with seven arms is abnormal; there are two IIBr 4 (3+4) series, each bearing one IIIBr 2 series, one internal and the other external; the external IIIBr series bears outwardly an undivided arm and inwardly a IVBr 7 (3+4) series, the inner arm from which has the first syzygy between brachials 14+15, while the outer (adradial) arm has syzygies between brachials 2+3 and 14+15; this last, according to Gislén, is in reality a pinnule that has developed into an arm and is directed ventrally just like a normal pinnule. (4) The arms are 6+6+5+5+7 =29; the cirri are XXV, 28–32, from 20 to 24 mm. long; the longest cirrus segments are one-third again as broad as long; P_2 is 9 mm. long, with 23 segments; P_3 is about 10 mm. long, with 22 segments. (5) There are 6+7+6+6+6=31 arms. (6) There are 6+6+6+7+7=32 arms about 75 mm. long; the IIBr series are 4 (3+4) and the IIIBr series are 2, except in one case. (7) There are 8+7+6+5+6=32 arms; the IIBr series are 2 or 4 (3+4). (8) The arms are 6+6+7+5(+)+8=32+.

A specimen from *Pieter Faure* station 2001 has the cirri with 25–27 segments, from 15 to 20 mm. long; the arms are 5+5+5+4, with one broken ray; seven of the eight IIBr series are 4(3+4); two of the three IIIBr series are 2; P_3 is about 10 mm. long with 20 segments. Another specimen from the same station is much broken; there are two loose rays with four and six arms. A third specimen from the same station has 6+5+5+6+5=27 arms.

A specimen from *Pieter Faure* station 2012 has 29 arms about 75 mm. long; of the ten IIBr series present eight are 4(3+4) and two are 2; five of the IIIBr series, four of these following IIBr 2 series, are 4(3+4), and four are 2. In another specimen from the same station the cirri are XXXII, 29–33, from 12 to 22 mm. long; the longest cirrus segments are one-third again as broad as long; the arms are 8+7+7+8+9 = 39, 75 mm. long; of the ten IIBr series seven are 4(3+4) and three are 2; 12 of the IIIBr series are 2, three are 4(3+4), and one is 6(3+4); of the three IVBr series two are 2 and one is 4(3+4).

Remarks.—Professor Gislén wrote that in the short arms and the relatively few pinnule segments this form approaches *H. schlegelii*, from which, however, it differs in having at least twice as many arms. In the short cirrus segments it comes near *H. flora* which has fewer, but much longer, arms. He described this form as a variety of *H. africana* in order not to increase the number of doubtful and critical species in the genus *Heterometra* in which, as he quite justly remarks, there are probably too many species at present recognized. It seems to me that the short cirrus segments and brachials suggest a closer relationship with *H. flora* than with *H. africana*, and I therefore prefer to regard it as a distinct species related to that form. This is purely a matter of personal opinion in which Profession Gislén is quite as likely to be right as I.

Localities.—*Pieter Faure* stations 1987, 2001, 2012, ?2079, in the vicinity of Delagoa Bay, Portuguese East Africa; Dr. J. D. F. Gilchrist, ?1925 [Gislén, 1938].

Unidentifiable Species

HETEROMETRA DELICATA H. L. Clark

Heterometra delicata H. L. Clark, Carnegie Inst. Washington Publ. 212, 1915, p. 105 (description; Friday Island); Echinoderm fauna of Torres Strait, 1921, p. 8 (secured by the Carnegie Exped.), p. 21 (Friday Island; not a *Zygometra;* possibly a young *Amphimetra*), pl. 21, fig. 6, pl. 36, figs. 4, *a–f*.

Zygometra punctata A. H. Clark, Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 60, footnote 1 (includes *Heterometra delicata*).

Description.—The centrodorsal is relatively large, 2 mm. in diameter, low subconical, with only the dorsal pole bare.

The cirri are XV, 18–19, about 5 or 6 mm. long, long and rather stout, little compressed distally. None of the segments are longer than broad. The 10–12 distal segments have conspicuous longitudinal dorsal crests or teeth. The opposing spine is large.

The elements of the IBr series and the first two brachials have small ventrolateral processes.

The 10 arms are about 25 mm. long and are composed of about 50–60 brachials, which are more or less quadrate and are distinctly longer than broad on the distal part of the arm.

Syzygies occur between brachials 3+4 and 9+10 and distally at intervals of 7–10 muscular articulations.

P_1 is less than 2 mm. long and is composed of 10 or 11 short segments of which the basal are squarish. P_a is similar but much smaller and has only six segments. P_2 is similar to P_1 but is more than 2 mm. long and is rather stout with 10 segments, decidedly the largest pinnule on the arm. P_b is about equal to P_1 or a trifle larger but has fewer segments. The distal edges of the segments of P_2 and P_b are somewhat flaring and very minutely spiny. P_3 is smaller than P_1 and has only six segments. P_c is similar but smaller. The pinnules succeeding become gradually larger until at the middle of the arm they are about 3 mm. long and have 12 segments. None of the basal pinnules are rigid and spikelike, but all have rather flagellate tips.

The color is purple of a rather pale shade; the pinnules are yellowish at the tips and the cirri are more or less white. Dr. Clark said that the colors are fairly well preserved in alcohol.

Remarks.—The single specimen (M.C.Z., 587) upon which this species was based was picked up on the sand flat on the southern side of Friday Island, Torres Strait, at low tide, on September 13, 1913. Dr. Clark said that its relationships are obscure, for although it seems to be a member of the family Himerometridae the outer brachials preclude its being placed in *Amphimetra*, while the known species of *Heterometra* all have more than 10 arms. It may perhaps need a new generic name of its own.

The description of this new species reached me just as I was finishing the report upon the *Siboga* collection, and after studying it, noting especially the short cirri, I became convinced that Dr. Clark had been misled by a specimen of *Zygometra punctata*, which I had first mistaken for *Heterometra bengalensis* (see page 123). So in a footnote to *Zygometra punctata* as given in the key to the species of *Zygometra* I said that it included *Heterometra delicata* H. L. Clark. Farther on, in a discussion of *Z. punctata*, I said that Dr. Clark had redescribed this species under the name of *Heterometra delicata*, basing his description upon a specimen which he found on the sand flat on the southern side of Friday Island, Torres Strait.

In 1921 Dr. Clark said that the holotype of this species does not seem to be one of the Zygometridae at all. There are no traces of syzygies or of pseudosyzygies in the IBr series, the joints being perfectly normal muscular articulations. The IBr_1 are not short and bandlike, as in *Zygometra punctata*, but the width is only a little more than twice the length. The IBr_2 (axillaries) are pentagonal, not twice as broad as long. The radials are not concealed by the centrodorsal. None of the basal segments of the cirri are twice as broad as long. Finally, the color is quite unlike that of *Z. punctata* or any other member of that genus; there is no white save on the cirri, which are more or less light colored. He remarked that this puzzling little comatulid (M.C.Z. 587) is very probably a young individual not yet revealing its species characters, and that it may possibly be a young *Amphimetra*. He added that since examining it I had decided that it is altogether too young for determination.

Genus HOMALOMETRA A. H. Clark

Antedon (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 130, and following authors.
Nanometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 349.
Amphimetra (part) A. H. Clark, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 441.
Homalometra A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, pp. 72, 73 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 18, 22, 44, 46.

Diagnosis.—A genus of Himerometridae in which the arms are 10 or 11 in number, the IIBr series when present being 4(3+4), and the cirri are slender, only very slightly curved, slowly tapering distally, and composed of 25–30 segments, of which all but the basal are markedly longer than broad and of which the distal are smooth dorsally, being quite without dorsal spines or tubercles.

Geographical range.—From the Arafura Sea to the western end of New Guinea.

Bathymetrical range.—The two records are 90 and 95 meters.

Remarks.—The genus *Homalometra* is very closely related both to *Heterometra* and to *Amphimetra*, but it is at once distinguished for both by its peculiar cirri, The slenderness and delicacy of these organs, combined with the rather small size of the animal, give it very much the appearance of a macrophreate form.

The genus *Homalometra* bears somewhat the same relation to *Amphimetra* that *Craspedometra* does to *Heterometra*. The single species of *Craspedometra* may be considered as a stout and rather large species of *Heterometra* with tapering sharp pointed and smooth cirri, while the single species of *Homalometra* may be regarded as a slender and rather small species of *Amphimetra* with tapering and smooth cirri.

History.—In describing the single species of *Homalometra* in 1888 Dr. P. H. Carpenter referred it to *Antedon*. In 1907 when I revised the old genus *Antedon*, Carpenter's *Antedon denticulata* was referred to the new genus *Nanometra*. After an examination of the type specimen in the British Museum in 1910, the species was assigned, in 1911, to the genus *Amphimetra*.

The generic name *Homalometra* first appeared in the report on the unstalked crinoids of the *Siboga* expedition published in 1918. It was not formally defined, but the name was inserted in the key to the genera of the family Himerometridae, and a second specimen of the type species was described under the heading *Homalometra denticulata.*

HOMALOMETRA DENTICULATA (P. H. Carpenter)

PLATE 37, FIGURES 166, 167

Antedon denticulata P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 130 (description; *Challenger* station 190), pl. 22, figs. 1, 2.—BELL, Ann. Mag. Nat. Hist., ser. 6, vol. 2, 1888, p. 403 (comparison with *A. wilsoni* [*Ptilometra macronema*, young]).—HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, 1895, p. 130 (systematic and bathymetrical relationships).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1578 (listed).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 33 (identity).

Nanometra denticulata A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 349 (listed).

Amphimetra denticulata A. H. CLARK, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 441 (Australian tropical species; Arafura Sea); Crinoids of the Indian Ocean, 1912, p. 33 (identity), p. 113 (synonymy; habitat; notes on the type specimen); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 25 (published reference to the specimen in the B. M.; *Challenger* station 190).

Homalometra denticulata A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 91 (references; detailed description; station 167), p. 273 (listed), pl. 5 (colored figure), pl. 27, figs. 101, 102.—GISLÉN, Arkiv för Zoologi, vol. 19, No. 32, 1928, p. 5, No. 18 (notes).

Description.—The centrodorsal is very thin, discoidal, with a broad, very slightly convex, dorsal pole 1.5 mm. in diameter, which bears numerous very small scattered tubercles, among which, about the border, are larger irregular flattened tubercles, frequently surrounded by a circle of the smaller ones, apparently indicating the location of obsolete cirrus sockets. The cirrus sockets are arranged in a single slightly irregular marginal row.

The cirri are XIII, 27–29, from 25 to 27 mm. long, very slender, gradually and slowly tapering to a point, only slightly and irregularly curved. The first segment is very short, the second is about twice as broad as long, the third is from about as long as broad to half again as long as broad, and the fourth and fifth and following are about four times as long as broad, becoming slightly shorter (from two and one-half to three times as long as broad) toward the end of the second third of the cirri, and longer again terminally. The longer cirrus segments are very slightly constricted centrally; those in the outer third of the cirri have the ventral and dorsal profiles more nearly straight. The terminal claw is very long and very slender, about as long as the preceding segment, with the tip more or less curved downward.

The edges of the radials are bordered by a row of small rounded beadlike tubercles, and there are smaller and less conspicuous tubercles scattered over their surface in the interradial angles. The IBr_1 are very short, more than four times as broad as long. The IBr_2 (axillaries) are low triangular, twice as broad as long. The IIBr series are 4(3+4). The ossicles of the division series and first two brachials have slight lateral extensions and are sharply flattened laterally as far as the base of P_1.

The 11 arms are 90 mm. long. The first brachial is very short, about four times as broad as long, only slightly wedge-shaped. The second is irregularly quadrate, about three times as broad as the median length. The first syzygial pair (composed of brachials 3+4) is remarkable for its extreme shortness, being about three times as broad as long, slightly longer inwardly than outwardly, the hypozygal oblong, the epizygal wedge-shaped. The next four brachials are nearly oblong, with the distal border produced. The following brachials are remarkably uniform, slightly wedge-shaped, about four times as broad as the median length, in the middle of the arm becoming about three times as broad as long and at the arm tip about as long as broad. When the arm is viewed from the side the dorsal profile of the brachials, though approximately straight, is seen to make a considerable angle with the axis of the arm so that the profile of the arm as a whole is very strongly serrate. The prominent distal edges of the brachials are very finely spinous.

P_1 is 7 mm. long, slender and becoming very delicate distally, composed of 22 segments of which the first is much broader than long and the following gradually increase in length, becoming about as long as broad on the eighth and twice as long as broad terminally; the second-fifth have a high carinate process the crest of which is parallel with the longitudinal axis of the segments; the first has a similar but less-marked process; the sixth has a triangular keel that is proximally as high as the keel on the preceding segment but runs to a point distally; the sixth and following increase in width from the proximal to the distal end, making the latter very prominent; the segments beyond the eighth are low triangular in section, with a more or less rounded dorsal ridge. P_2 is 9 mm. long, with about 20 segments, similar to P_1 but slightly larger with proportionately longer segments, these becoming about three times as long as broad distally; the second-fourth segments are carinate, like the second-fifth in P_1; the fifth has a triangular keel like the sixth in P_1; the second and following have the distal dorsal corner swollen and slightly produced. P_3 is 12 mm. long with 18 or 19 segments, much larger than the pinnules preceding; it tapers more rapidly in the first four segments than beyond and remains rather stiff distally; the first segment is irregularly triangular, not quite twice as broad as long, the second is approximately oblong, about twice as broad as long, the third is slightly broader than long, and the fourth is about one-third again as long as broad; the following segments gradually increase in length, in the outer fourth of the pinnule becoming three times as long as broad or even longer; the first segment has a dorsal tubercle; the second-fourth bear a narrow straight edged carinate process; the fifth has a narrowly carinate process in the proximal half; on the second there is a slight projection of the dorsal distal angle, which rapidly increases in size, becoming on the fourth and following a very prominent, through narrow, projection of the distal dorsal angle involving about the distal fourth of the dorsal edge, which is armed with fine spines. P_4 is about 7 mm. long, with 13 segments, tapering more rapidly in the first four segments than subsequently, resembling P_3 but proportionately smaller with the projection of the distal dorsal angles of the segments much less marked and the proximal segments only very slightly carinate. P_5 is 6 mm. long with 13 segments, which become about as long as broad on the fourth, and on the eighth and following from three to four times as long as broad, with the distal dorsal angles slightly produced. The distal pinnules are 8 mm. long, with 17–19 segments, most of which are about three times as long as broad, smooth and cylindrical, without produced or spinous distal ends.

Notes.—The preceding description is taken from the specimen dredged by the *Siboga* south of Salawatti.

The characters of the type specimen dredged by the *Challenger* are, according to Carpenter, as follows: The centrodorsal is hemispherical, with a denticulate rim. The cirri are XX–XV, 25–30; nearly all the cirrus segments are longer than broad, the fifth and sixth being the longest. The cirri are smooth dorsally, the outer segments having no dorsal processes. The radials are concealed. The IBr$_1$ are short and rather convex in the center. The IBr$_2$ (axillaries) are short and widely pentagonal with slight backward projections. The elements of the IBr series and the first two brachials are sharply flattened laterally with straight edges and the margins of the dorsal surface flattened. The 10 arms are perhaps 70 mm. long. The lower brachials are nearly oblong and those following are smooth, short, and bluntly wedge-shaped, gradually becoming more oblong about the middle of the arm. Syzygies occur between brachials 3+4, again from between brachials 13+14 to between brachials 14+15, and distally at intervals of from 5 to 7 muscular articulations. P$_1$ is rather longer than P$_a$, and the following pinnules increase in length to P$_3$ and P$_c$, which consist of about a dozen segments, the lowest of which are broad and slightly carinate. P$_4$ and P$_d$ are smaller with relatively longer segments, and the following pinnules slowly increase in length. Sacculi are apparently absent. The color in alcohol is very light brown.

Gislén examined the type specimen of *denticulata* at the British Museum in 1925. He said there is a small opposing spine, as was shown in Carpenter's figure. He suggested that probably the specimen from *Siboga* station 167 belongs to another species, as the cirri seem to be evenly tapering without any opposing spine.

Localities.—*Challenger* station 190; Arafura Sea, southeast of the Aru Islands (lat. 8°56′ S., long. 136°05′ E.); 90 meters; green mud; September 12, 1874 [P. H. Carpenter, 1888; Bell, 1888; Hartlaub, 1891; A. H. Clark, 1907, 1911, 1912, 1913] (1, B. M.).

Siboga station 167; south of Salawatti, off the western end of New Guinea (lat. 2°35′30″ S., long. 131°26′12″ E.); 95 meters; August 22, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Geographical range.—Known only from the Arafura Sea and from off the western end of New Guinea.

Bathymetrical range.—The two records are 90 and 95 meters.

History.—This species was first described in 1888 by P. H. Carpenter under the name of *Antedon denticulata* from a single specimen from *Challenger* station 190. In my first revision of the old genus *Antedon* published in 1907 *denticulata* was placed in the new genus *Nanometra*. In 1911 it was transferred to the genus *Amphimetra*. In 1918 I referred to this species and described a second specimen from *Siboga* station 167, at the same creating the new genus *Homalometra* for its reception. Gislén in 1928 suggested that probably the *Siboga* specimen represents a species different from that described by Carpenter.

Genus AMPHIMETRA A. H. Clark

Comatula (part) Guérin-Méneville, Iconographie du règne animal de G. Cuvier, 1828–1837, pl. 1, figs. 2, 2*a*, and following authors.

Alecto (part) J. Müller, Monatsb. Preuss. Akad. Wiss., 1841, p. 184.

Comatula (*Alecto*) (part) J. Müller, Monatsb. Preuss. Akad. Wiss., 1846, p. 178.

Antedon (part) Wyville Thomson, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 537, and following authors.

Antedon (*Comatula*) (part) Pourtalès, Bull. Mus. Comp. Zool., vol. 1, 1869, p. 356.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Oligometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 126; vol. 22, 1909, pp. 7, 42.

Amphimetra A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 6 (diagnosis; genotype *Comatula* [*Alecto*] *milberti* J. Müller, 1846), p. 175 (referred to the Himerometrinae); Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 2, 13 (common to southeastern Africa and Ceylon; absent from Arabian Sea); Mem. Australian Mus., vol. 4, 1911, pp. 731, 732 (in keys), p. 734 (key to Australian species), p. 764 (original reference; characters; range); Crinoids of the Indian Ocean, 1912, p. 10 (purely tropical species do not extend north of Formosa), p. 11 (represented in Ceylon region; this the western limit of the large and highly multibrachiate species [*Heterometra*]), p. 12 (represented in southeast African region [*Heterometra*]), p. 21 (found throughout the range of the family Himerometridae [with certain species of *Heterometra* included]), p. 56 (in key), p. 107 (original reference; synonymy).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 371 (discussion).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 73 (in key; range), p. 82 (key to the included species).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, pp. 3, 23; Zool. Bidrag Uppsala, vol. 9, 1924, p. 88 (synarthrial tubercles); Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 18, 44, 46.—Boone, Bull. Vanderbilt Marine Mus., vol. 7, 1938, pp. 122, 123.

Comatula (*Antedon*) (part) A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 251 (from P. H. Carpenter, MS.).

Actinometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 75 (B. M., MS.).

Heterometra (part) Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 39, footnote.

Diagnosis.—A genus of Himerometridae in which the arms are normally 10 in number with the brachials beyond the proximal portion of the arms very short with parallel, or approximately parallel, ends; the cirri are of moderate length with all, or at least the outer, segments broader than long, and bear conspicuous dorsal spines or tubercles in the distal portion; the enlarged proximal pinnules, though stouter and somewhat longer than those following, are not especially distinguished; they are only very slightly, if at all, carinate basally, and the outer ends of their distal segments are usually smooth, though they may bear fine spines.

Occasional individuals of certain forms may have more than 10 arms, in which case the IIBr series are 2 instead of 4 (3+4), as in the other genera of Himerometridae.

Geographical range.—From southern Japan southward to the Philippines, Tonga and Fiji, Port Molle, Queensland, and between Fremantle and Geraldton, Western Australia, and westward to the Maldive Archipelago.

Bathymetrical range.—From the low-tide mark—sometimes even the intertidal zone—down to 109 (?183) meters. The species of *Amphimetra* are especially characteristic of the zone from the low-tide mark down to about 50 meters. All the eight species and forms have been taken in shore collecting, and Prof. Sydney J. Hickson told me that at Macassar he had found a 10-armed comatulid (undoubtedly a species of this genus) hanging from the piling of a dock just above the water at low tide. Only half of the total number of species are known from a depth greater than 50 meters, and only one is known from a depth exceeding 100 meters.

Remarks.—The genus *Amphimetra* includes eight forms, three of which (*tessellata*, *discoidea*, and *papuensis*) are herein treated as geographical races of a single specific type. Two species, *ensifer* from Singapore and *laevipinna* from southern Japan, appear to be quite distinct from each other and from all the rest. The remaining forms, though very distinct when typically developed, approach each other more or less closely or even intergrade so that their real status is not as yet wholly clear.

The very large and stout *tessellata*, characteristic of the area from the Sunda Straits to the Moluccas and Kei Islands and the coast of Western Australia, to the eastward passes into the smaller and slenderer *discoidea*, which is characteristic of the Queensland coast and the region northward to Singapore, the Philippines, and Formosa. Still farther eastward, in southeastern New Guinea, Tonga, and Fiji, it is represented by the still smaller and slenderer *papuensis.* Many specimens from northern Australia are intermediate between *tessellata* and *discoidea,* and specimens from southeastern New Guinea are more or less intermediate between *discoidea* and *papuensis.*

The group of species including *spectabilis, molleri,* and *pinniformis* seems to be distinct from the *tessellata* group; but certain specimens of *tessellata* approach *spectabilis* rather closely, and some specimens might be assigned almost equally well either to *molleri* or to *discoidea.*

The relation between *Amphimetra spectabilis* and *A. molleri* is much the same as that between *tessellata* and *discoidea,* and it may be that *spectabilis* is simply a large local form of *molleri.* Probably *pinniformis* is simply a small local form of *molleri*—at any rate it appears to be very closely related to it.

The color of the various forms is to a certain extent distinctive. Thus *tessellata* is always very dark, varying (in alcohol) from dark brownish red to deep purple or black, *discoidea* is lighter, ventrally yellow-brown to violet or purple and dorsally grayish white or flesh color with the cirri becoming purple distally, though occasionally unicolor and dark like *tessellata,* and *papuensis* is, like *tessellata,* uniform dark red-brown. The two known specimens of *spectabilis* are both light and grayish white with the ventral surface darker, and *molleri* is usually gray or light grayish brown, but it may be reddish brown, yellowish brown, deep purple, or violet, or the dorsal skeleton may be white or whitish and the ventral surface dark. *A. ensifer* varies from nearly white to dark yellowish or purplish brown with the perisome and the ends of the cirri darker, and *laevipinna* is light brown with purplish bands on the arms, or plain grayish or brownish white.

Though the color of the species of *Amphimetra* is more closely correlated with the systematic interrelationships than is the case with most comatulids living in shallow water, it is by no means to be relied upon as an indication of the systematic affinities of any individual specimen.

Although the exceedingly short brachials, resembling those of the species of *Himerometra* and of many of the species of *Heterometra,* appear conclusively to indicate that *Amphimetra* finds its proper place in the family Himerometridae, this genus presents certain features suggesting an approach to the Colobometridae.

In *A. tessellata tessellata* occasional specimens are found having more than 10 arms, in which case the IIBr series are always 2 as in *Cenometra, Cyllometra,* and *Epimetra*—in fact in all the multibrachiate genera except *Petasometra*—of the Colobometridae. Also in *A. tessellata tessellata* the dorsal processes on the cirrus segments are occasionally broadened laterally, forming a transverse ridge or paired spines in the fashion so characteristic of the species of Colobometridae. The enlarged lower pinnules in the species of *Amphimetra* are by no means so highly modified as they are in the other genera of the family Himerometridae. They show an approach to the conditions in the more generalized species of *Decametra* and *Oligometra,* this approach being especially close in *A. tessellata papuensis,* in which the lower pinnules are unusually slender.

But in spite of its approach to some of the genera of the Colobometridae, *Amphimetra* agrees better in the sum total of all its characters with the more generalized species of *Heterometra* than it does with any of the genera of Colobometridae.

It should be borne in mind that, except only in the case of the enlarged proximal pinnules in the smallest forms, the features characteristic of the Colobometridae as contrasted with the Himerometridae—the occurrence of IIBr 2 series and the lateral broadening of the dorsal processes on the cirrus segments—are found only very exceptionally in occasional individuals of the largest form of the largest species (*A. tessellata tessellata*).

History.—The first notice of a species of this genus was the publication by Guérin-Méneville in 1828–1837 of a figure identified as *Comatula carinata* (= *A. tessellata discoidea*).

Prof. Johannes Müller in 1841 published the first description of a species of this genus, calling it *Alecto tessellata*. In 1846 he described two additional species, calling them *Comatula* (*Alecto*) *milberti* and *Comatula jacquinoti*.

Dujardin and Hupé in 1862 redescribed Müller's three species under the generic name *Comatula*. In 1865 Prof. Sir Wyville Thomson referred to one of Müller's species (*tessellata*) under the generic name of *Antedon*, and in 1869 Count Pourtalès referred to another (*milberti*) under the generic combination *Antedon* (*Comatula*). All subsequent authors up to 1907 have assigned the species of *Amphimetra* to *Antedon*.

Dr. P. H. Carpenter in the *Challenger* report on the comatulids published in 1888 established a special group called the *Milberti* group to include species of *Antedon* in which the pinnules of the first pair are comparatively small with their component segments but little longer than broad, and one or more of the second, third, or fourth pairs are more massive with stouter segments than their successors.

To the *Milberti* group he assigned the following 14 species: *pinniformis* (= *Amphimetra pinniformis*), *serripinna* (= *Oligometra serripinna*), *carpenteri* (= *Oligometra carpenteri*), *pumila* (= *Compsometra loveni*), *milberti* (= *Amphimetra tessellata*), *laevissima* (= *Amphimetra molleri* + *Decametra*, sp.), *tessellata* (= *Amphimetra tessellata*), *perspinosa* (= *Colobometra perspinosa*), *anceps* (= *Heterometra quinduplicava*, 10-armed individuals), *variipinna* (= *Heterometra crenulata*, 10-armed individuals), *carinata* (= *Tropiometra carinata*), *parvicirra* (= *Dorometra parvicirra*), *informis* (= *Decametra informis*), and *loveni* (= *Colobometra perspinosa*). He remarked that *tessellata* was the only comatulid of which he had not seen the type specimen.

Carpenter wrote that this is a somewhat heterogeneous group, and he had had considerable trouble in working out an arrangement that he could regard as even approximately satisfactory. He noted that the definition given would almost include such forms as (*Isometra*) *angustipinna* and (*Thysanometra*) *tenuicirra*, which he assigned to the *Tenella* group (see Part 5), while (*Dorometra*) *parvicirra*, which he placed in the *Milberti* group, though with some doubt, has many points of resemblance with *Antedon rosacea* (= *bifida*) and *A. dübeni*. He said that *milberti* (= *tessellata*; but most of the specimens he had examined were *molleri*) itself exhibits traces of the wall-sidedness of the IBr series and lower brachials which is so marked in the *Basicurva* group (see Part 4b), while (*Tropiometra*) *carinata* differs in many respects from (*Oligometra*) *serripinna*, *milberti*, and the typical members of the group, so that another group may have to be established for it at some future time.

Carpenter said that the special character that distinguishes the *Milberti* group is the large size of one or more of the second, third, and fourth pairs of pinnules, and remarked that this feature is well shown in *anceps* (=*Heterometra quinduplicava*, 10-armed individuals), *milberti* (=*tessellata*, or more likely, *molleri*), *variipinna* (=*Heterometra crenulata*, 10-armed individuals), and also in some species described by Bell in the *Alert* report, while it reappears in a more marked degree in some of the multibrachiate species. He noted that in some cases, as in *milberti* (referring chiefly to *molleri*), the second, third, and fourth pairs are all of greater size than the pinnules above and below them, sometimes the second and sometimes the third pairs being the largest. He remarked that in *anceps* (=10-armed individuals of *Heterometra quinduplicava*) and in *variipinna* (=10-armed individuals of *Heterometra crenulata*) the pinnules of the fifth or sixth brachials (P_b and P_3), or both, are considerably longer and stouter than their fellows, and in *carpenteri* (=*Oligometra carpenteri*) and in *pumila* (=*Compsometra loveni*) the large pinnule is on the fourth brachial (P_2). But in *carinata* (=*Tropiometra carinata*) and in *parvicirra* (=*Dorometra parvicirra*) the third and following pairs of pinnules are much more equal in size.

At the end of the *Milberti* group Carpenter placed two "abnormal" species, *informis* (=*Decametra informis*) and *loveni* (=*Colobometra perspinosa*), in which P_a is absent, though in other respects, he said, they conform pretty well to the general type.

In my first revision of the genus *Antedon* published in 1907 the species placed by Carpenter in the *Milberti* group were distributed in the following genera—*Himerometra* (*milberti*, *tessellata*, *anceps*, and *variipinna*); *Antedon* (*serripinna*, *carpenteri*, *pumila*, and *parvicirra*); *Cyllometra* (*perspinosa*, *informis*, and *loveni* [renamed *Cyllometra belli*]); and *Tropiometra* (*carinata*); *pinniformis* and *laevissima* were not mentioned.

Toward the end of 1908 I described *Himerometra molleri*, *H. schlegelii*, *H. producta*, and *H. ensifer* from specimens in the collection of the Zoological Museum at Copenhagen, and about two weeks later I described *H. discoidea* from specimens in the United States National Museum.

In the revision of the family Himerometridae published in 1909 I established the new genus *Amphimetra* with *Comatula* (*Alecto*) *milberti* J. Müller, 1846, as the genotype, including in it *anceps*, *ensiformis* (*sic*), *laevissima*, *milberti*, *molleri*, *producta*, *schlegelii*, *tessellata*, and *variipinna*.

In the key to the genera of Himerometridae *Amphimetra* was paired with *Himerometra*, these two genera being differentiated from all the related genera by having the middle and distal brachials extremely short and oblong, and the elements of the IBr series and lower brachials strongly convex dorsoventrally, appearing swollen. From *Himerometra* it was separated by having the IBr series and first two brachials in apposition for their entire length, strongly developed synarthrial tubercles, P_1 smaller and slenderer than P_2, and 10–20 arms, whereas in *Himerometra* the division series are rounded dorsally and widely separated laterally, synarthrial tubercles are not developed, P_1 resembles P_D and P_P and is larger than P_2, and there are more than 25 arms.

Later in 1909 I described *Amphimetra mortenseni* (June 19) and *A. parilis* (August 23).

In a paper on the crinoids of the African coasts published in 1911 I described *Amphimetra* (=*Heterometra*) *africana,* and in a memoir on the crinoids of Australia I published a key to the Australian genera in which *Amphimetra* was separated from *Craspedometra* and *Heterometra* by the same character—the very short brachials—used in 1909. The Australian species included *variipinna* (=*Heterometra crenulata*), *milberti* (=*A. tessellata tessellata*), and *discoidea* (=*A. tessellata discoidea*).

In a paper on the crinoids of the Leyden Museum published in 1911 I gave notes on the type specimen of *Amphimetra pinniformis,* and in a paper on the crinoids of the Paris Museum published in the same year I described the type specimen of Müller's *philiberti* under the name of *Amphimetra philiberti* (under which I placed *A. mortenseni* as a synonym), gave notes on the type specimen of *Comatula jacquinoti,* calling it *Amphimetra milberti,* and recorded a specimen of *Amphimetra discoidea.*

In my memoir on the crinoids of the Indian Ocean published in 1912 I differentiated *Amphimetra* from *Heterometra* on the ground that in the former the middle and distal brachials are excedingly short and discoidal and the elements of the IBr series and lower brachials are swollen, whereas in the latter the middle and distal brachials are more or less obliquely wedge-shaped and not especially short, and the elements of the IBr series and lower brachials are not swollen. I said that the species of *Amphimetra* have 10 or more arms, those of *Heterometra* more than 10 arms. Under *Amphimetra* I included *philiberti* (with *Amphimetra mortenseni* as a synonym), *variipinna, producta, schlegelii, africana, milberti, laevissima, molleri, parilis, discoidea, ensifer, denticulata* (*Antedon denticulata* P. H. Carpenter, 1888), and *pinniformis.*

In 1912 Dr. Clemens Hartlaub published a short account of my treatment of the *Milberti* group but did not comment upon it. In his discussion of the included species he used Carpenter's classification. A specimen of *Antedon milberti* (=*Amphimetra tessellata tessellata*) was described and figured.

In 1913 Dr. August Reichensperger recorded and described specimens of *Amphimetra variipinna, A. discoidea,* and *A. milberti,* and critically discussed the interrelationships of the last two.

In a paper on the crinoids of the British Museum published in 1913 I gave notes on specimens of *Amphimetra crenulata, A. nematodon, A. anceps, A. producta, A. flora* (sp. nov.), *A. africana, A. milberti, A. molleri, A. discoidea, A. papuensis* (this name here appears for the first time), *A. pinniformis,* and *A. denticulata.*

For some time it had been apparent that *Amphimetra* was quite untenable on the basis of the characters assigned to it in 1909, 1911, and 1912, and in the sense in which it was used in the report on the crinoids of the British Museum in 1913. No hard and fast line could be drawn between species with exceedingly short and those with longer brachials. Though generally speaking such a division was indicated in the species of Himerometridae with P_1 smaller than P_2 and the cirri not smooth and tapering to a point distally, the shape of the brachials varies with age and size, and in some species there is always considerable individual variation. The wholly unsatisfactory nature of the character chiefly relied upon for separating *Amphimetra* from *Heterometra* was clearly shown by the inclusion of *anceps* in *Amphimetra* and *quinduplicava* in *Heterometra* in 1909, *anceps* and *quinduplicava* subsequently proving synonymous.

The relations between *Amphimetra* and *Heterometra* were therefore reexamined, and in my report on the unstalked crinoids of the *Siboga* expedition published in 1918 I restricted the genus *Amphimetra* so as to include only *spectabilis* (here mentioned for the first time), *molleri, parilis, jacquinoti, pinniformis, discoidea, ensifer, laevipinna,* and *papuensis*. Except for the inclusion of *parilis*, herein referred to *Heterometra*, *Amphimetra* was given the same status as in the present volume, and only 10-armed species were assigned to it. A new genus, *Homalometra*, was established for *Antedon denticulata* P. H. Carpenter, 1888, previously referred to *Amphimetra*. No revised diagnosis of the genus *Amphimetra* was published, but the scope of the genus, and also of *Heterometra*, was made clear by keys to the included species. The complete synonymy of all the species of *Amphimetra* was given, and the distribution of each was given in detail. In addition to the nine species given above, three (*milberti, sinensis* [*Antedon sinensis* Hartlaub, 1912], and *tessellata*) were listed as doubtful species, as at the time their relationships could not be satisfactorily determined.

In 1919 Dr. Torsten Gislén discussed the relationship between *variipinna* and *crenulata* and also that between *milberti* and *discoidea*, uniting them into *variipinna* and *milberti*, respectively. He also discussed the relationship of *schlegelii* with the last. All these forms he referred to *Amphimetra*, his paper having been written before he had seen the *Siboga* report.

KEY TO THE SPECIES AND SUBSPECIES OF THE GENUS AMPHIMETRA

a^1. Cirri very stout, composed of short subequal segments, which are never more than half as long as broad; segments in outer portion of cirri are very slightly longer than those in proximal portion and bear small sharp median spines; cirri are very flexible and are more or less evenly curved throughout their entire length.

  b^1. Size large, arms 200 mm. long; cirri large and stout with 45–51 segments, most of which are about 4 times as broad as long; dorsal spines are developed from usually the sixteenth or seventeenth segment onward (Philippine Islands; 0–64 meters)........**spectabilis** (p. 347)

  b^2. Smaller, arms not over 150 mm. long; cirri with 24–50 segments, which are 2–3 times as broad as long; dorsal spines are developed before eighth segment.

    c^1. Larger, arms 75–150 mm. long; cirri with usually 30–35 segments; P_2 with 18–21 segments (Maldive Islands to Philippines; 0–55 [?66] meters)..................**molleri** (p. 349)

    c^2. Smaller, arms about 60 mm. long; cirri with 25 segments; P_2 with 12 segments (New Guinea and northwestern Australia; 0–27 meters)......................**pinniformis** (p. 358)

a^2. Cirri less stout, segments in proximal half varying from nearly twice as broad as long to slightly longer than broad, segments in distal half (except for a few terminal) shorter, always much broader than long; cirri more or less stiffened in proximal portion though flexible distally, so that they are strongly curved distally but much less curved proximally.

  b^1. Longest cirrus segments usually half again as broad as long, but varying from nearly twice as broad as long to nearly as long as broad; cirri with 35–47 segments, 30–50 mm. long; earlier segments sometimes with a broad transverse ridge or paired spines; arms 130–300 (usually 150–200) mm. long, usually 10, but occasionally 11–12, with the IIBr series 2; color uniform dark purple or violet (Sunda Straits to Moluccas and Kei Islands and southward to Port Molle, Queensland, and to between Fremantle and Geraldton, Western Australia; 0–109 ?[183] meters)..**tessellata tessellata** (p. 360)

  b^2. Longest cirrus segments about as long as broad.

    c^1. Synarthrial tubercles not extravagantly developed, though they may be prominent.

      d^1. Larger, arms 110–200 mm. long; 34–51 cirrus segments of which the outer bear short dorsal spines or pointed tubercles; synarthrial tubercles prominent and sharp pointed (Formosa and Philippine Islands to Singapore and southward to Port Molle, Queensland, and Holothuria Bank, northwestern Australia; 0–93 meters)..**tessellata discoidea** (p. 376)

- d^2. Smaller, arms 70–110 mm. long; 25–35 cirrus segments of which the outer bear long and sharp dorsal spines.
  - e^1. Synarthrial tubercles obsolete; pinnules slender with 17–18 segments, of which the basal are distinctly, though narrowly, carinate, and the outer have everted and dentate distal ends; arms up to 110 mm. long (southeastern New Guinea to Tonga and Fiji; littoral)--tessellata papuensis (p. 385)
  - e^2. Synarthrial tubercles prominent, though broad and blunt; lower pinnules stout with about 15 segments of which the basal are not carinate and the outer are entirely smooth; arms 70–95 mm. long (Japan)----------------------laevipinna (p. 389)
- c^2. Synarthrial tubercles extravagantly developed and produced; 23–40 (usually 30–35) cirrus segments; arms 80–120 (usually 80–100) mm. long; cirri 23–30 mm. long (Singapore; 0–13 meters)---ensifer (p. 387)

AMPHIMETRA SPECTABILIS A. H. Clark

PLATE 38, FIGURE 177; PLATE 39, FIGURES 183, 184

[See also vol. 1, pt. 2, fig. 193 (lateral view), p. 117.]

Himerometra milberti (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 52, 1908, p. 215 (*Albatross* station 5100), p. 216 (cirri compared with those of *Himerometra discoidea*).

Amphimetra milberti (part) A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Vid. Medd. Naturh. Foren. København, 1909, p. 156 (the species referred to under this name in the discussion of *A. molleri*); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 459 (comparison with a specimen of *discoidea* [in reality *tessellata*]); Mem. Australian Mus., vol. 4, 1911, p. 767 (record from Philippine Islands); Proc. U. S. Nat. Mus., vol. 39, 1911, p. 540 (Limborres Cave); Crinoids of the Indian Ocean, 1912, p. 111; Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 124 (comparison with *discoidea* [=*tessellata*]).

Amphimetra spectabilis A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 82 (in key; range), p. 83 (references; localities from which known).

Diagnostic features.—A large stout species with the arms 200 mm. long; the cirri are large and very stout, curved throughout, with 45–51 segments, most of which are about four times as broad as long; dorsal spines are developed from the sixteenth or seventeenth segments onward.

Description.—The centrodorsal is thick discoidal with a very strongly convex dorsal pole, which is almost completely covered with obsolete cirrus sockets rapidly decreasing in size toward the center. The cirri are arranged in two alternating marginal rows. The centrodorsal measures 6 mm. in breadth at the base and 4 mm. in height, and the bare dorsal pole is 4.5 mm. in diameter.

The cirri are XVIII, 45–51, 45 mm. in length, very stout, tapering slightly in the distal half, flexible throughout and usually curved for their entire length. The dorsal surface is somewhat flattened. The segments are subequal, most of them being about four times as broad as long. The last five or six decrease in width and become relatively longer, so that the antepenultimate is about twice as broad as the median length and the penultimate is but little broader than long. The distal ends of the segments are slightly thickened, especially dorsally and ventrally, and also roughened, projecting beyond, but not overlapping, the bases of the segments succeeding. The fourteenth-seventeenth (usually sixteenth or seventeenth) and following segments bear dorsal spines directed obliquely forward, which, although they arise from nearly the whole dorsal surface of the segments, become at the tip slender, sharp, and glassy. On the last two or three segments before the penultimate these spines become reduced to low pointed median tubercles. The opposing spine is larger than the dorsal processes on the preceding segments. It is triangular, arising from the entire dorsal surface of the penultimate segment; the anterior profile is straight or very slightly concave and strongly oblique, and the distal profile is straight, very slightly convex, or very slightly concave, and forms almost a straight line with the distal edge of the penultimate segment. The height of the opposing spine is equal to about half the width of the penultimate segment. The terminal claw is half again as long as the penultimate segment or somewhat shorter, rather slender, and moderately and evenly curved.

The distal ends of the radials are visible beyond the rim of the centrodorsal. They may form a very narrow band of approximately equal width throughout, or they may be almost wholly concealed by the centrodorsal in the median line. The IBr_1 are very short, about six times as broad as long, with the proximal and distal edges parallel if viewed at right angles to the dorsal surface. The anterolateral angles are more or less broadly rounded off, and the lateral edges are narrowly swollen. They are in lateral apposition as far as the rounded anterolateral angles. The IBr_2 (axillaries) are triangular, with the lateral angles slightly truncated, twice as broad as long, with the anterior borders only very slightly concave. The truncated lateral angles are very slightly and narrowly thickened and are in lateral apposition. There is a very prominent, though not produced, synarthrial tubercle on the articulation between the elements of the IBr series. The sides of the elements of the IBr series and of the first two brachials as far as the base of P_1 are sharply flattened, and the dorsolateral edge is slightly and narrowly everted or swollen.

The 10 arms are 200 mm. long. The first brachials are wedge-shaped, half again as long exteriorly as interiorly, united interiorly for almost their entire length. The second brachials are somewhat larger and are much more obliquely wedge-shaped. The first syzygial pair (composed of brachials 3+4) is oblong and exceedingly short. The next six or seven brachials are almost oblong, about five times as broad as long, and those succeeding become very obliquely wedge-shaped, almost triangular, about three times as broad as the length of their longer side. Later the brachials slowly become less and less obliquely wedge-shaped so that after the proximal third of the arm the brachials are oblong, very short, about 5 times as broad as long, becoming slowly somewhat longer toward the arm tip.

The first syzygy is between brachials 3+4, the second most frequently between brachials 9+10, and the third usually between brachials 16+17. The second syzygy is often between brachials 10+11, and it may be as late as between brachials 28+29. The distal intersyzygial interval varies from 10 to 60, but is usually between 10 and 16, muscular articulations.

P_1 is 11–12 mm. long and is composed of 25 segments. It is slender and flexible, tapering evenly in the proximal half and becoming flagellate and flexible in the distal half. The first segment is about as long as broad, the second is slightly longer than broad, and those following slowly increase in length to the eighth which, with the remainder, is from one-third to one-half again as long as broad. The second-fourth and proximal part of the fifth segments have the side toward the arm tip sharply rounded off, though not produced. P_2 is 14 mm. long, with 20–22 segments, much stouter than P_1 and tapering slowly and evenly to the tip. The first two segments are slightly broader than long, the third is almost as long as broad, the fourth is very slightly longer than broad, and those following are still longer, though not so much as one-third again as long as broad except for the three or four terminal which are from half again to twice as long as broad. The third-sixth segments have a faint trace of a sharpening along the side turned toward the arm tip. P_3 is 16–17 mm. long, with 20 segments, slightly stouter than P_2 basally and tapering more slowly so that it is markedly stouter in the distal half. P_4 is 13.5 mm. long, with 19 segments, and resembles P_3 but is less stout and the segments in the distal third are much longer, becoming terminally three times as long as broad. P_5 is 11 mm. long, with 19 segments. The distal pinnules are very slender and almost hairlike, 17 mm. long, with 34 segments, which in the proximal half are mostly between half again and twice as long as broad, becoming three times as long as broad distally.

The specimen described is from *Albatross* station 5100.

Localities.—*Albatross* station 5100; China Sea, off southern Luzon; south channel to Manila Bay; Corregidor Light bearing N. 16° E., 5.7 miles distant (lat. 14°17′15″ N., long. 120°32′40″ E.); 64 meters; gray sand; January 2, 1908 [A. H. Clark, 1908, 1909, 1911, 1912, 1918] (1, U.S.N.M., 35245).

Albatross; China Sea, off southern Luzon; Limbones Cove; littoral; February 8, 1909 [A. H. Clark, 1911 (as Limborres Cave), 1912, 1918] (1, U.S.N.M., 35196).

History.—The first known specimen of this species was dredged by the *Albatross* at station 5100 in the Philippines and was recorded by me in 1908 under the name of *Himerometra milberti*. As this specimen seemed to agree well with the description and figures of *milberti* given by Carpenter in the *Challenger* report, it was for a long time considered as representing the typical form of that species. Thus in 1909 the *milberti* with which *Amphimetra molleri* was compared was in reality this specimen, as was the *milberti* with which were compared the specimen of *discoidea* (=*tessellata*) from ?the vicinity of Perth recorded in 1911, and also the specimens of *discoidea* (=*tessellata*) from between Fremantle and Geraldton recorded in 1914.

In 1911 a second specimen was recorded, as *Amphimetra milberti*, from Limborres Cave (=Limbones Cove) where it had been collected by the *Albatross*.

In revising the species of *Amphimetra* for the *Siboga* report, I found that the species represented by these two specimens is quite different from any previously described. I therefore included its chief diagnostic characters in my key to the species of this genus and distinguished it by the name of *spectabilis*, giving the Philippines as its habitat. It has not heretofore been formally described.

AMPHIMETRA MOLLERI (A. H. Clark)

PLATE 38, FIGURES 169–171

Comatula laevissima (part) GRUBE, Jahresb. schlesisch. Ges. vaterl. Cultur, 1875, p. 74 (description; North Borneo).—P. H. CARPENTER, Proc. Zool. Soc. London, 1882 (1883), p. 746 (correctly referred by Bell to *Antedon*).

Antedon laevissima (part) BELL, Proc. Zool. Soc. London, 1882, p. 533 (listed).—P. H. CARPENTER, Proc. Zool. Soc. London, 1882 (1883), p. 746; *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 54 (10-armed species), p. 193 (in key), p. 197 (comparisons), p. 366 (bathymetric range), p. 378 (Borneo).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 34 (of P. H. Carpenter, 1888=*Amphimetra milberti* [error]), p. 40 (of Bell, 1902=*Amphimetra producta*+*A. molleri*+*Decametra taprobanes*+*D. möbiusi*), p. 289 (of Bell, 1902; account quoted); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 83 (of Bell, 1902=*Amphimetra* [*Heterometra*] *flora*+*Decametra möbiusi*+*Decametra taprobanes;* B. M., MS.=*Amphimetra producta*).

Antedon milberti von Graff, *Challenger* Reports, Zoology, vol. 10, pt. 61, 1887, p. 1 (Padau Bay, Mergui Archipelago; myzostomes).—Bell, Proc. Zool. Soc. London, 1888, p. 389, footnote 5 (collected by Anderson at Mergui).—P. H. Carpenter, *Challenger* Reports, Zoology, vol, 26, pt. 60, 1888, p. 194 (*Challenger* stations 203, 212; Padan Bay), pl. 35, figs. 4–6; Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 304 (specific formula), p. 310 (King Island, Mergui), pl. 27, figs. 6, 7 (proximal pinnules).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, pp. 81, 113 (Atjeh, Sumatra).—Chadwick, *in* Herdman, Rep. Ceylon Pearl Oyster Fisheries, vol. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon), p. 154 (stations i and lvii; characters).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, 1907, Abt. 3, p. 1580 (part; listed).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, pp. 377, 378 (specimen from Atjih, Sumatra; notes).

Antedon laevissima (part) Bell, *in* Gardiner, Fauna and geography of the Maldive and Laccadive Archipelagoes, vol. 1, 1902, p. 224.

Himerometra milberti (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra molleri A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 222 (description; "Indian Ocean"; also Straits of Malacca).

Amphimetra molleri A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Vid. Medd. Naturh. Forening København, 1909, p. 156 ("Indian Ocean"; Singapore; Straits of Malacca; description); Notes Leyden Mus., vol. 33, 1911, p. 181 (synonymy; Atjeh; description of the specimen); Crinoids of the Indian Ocean, 1912, pp. 34, 37, 40 (identity of previous records), p. 112 (synonymy; summary of published records), p. 316 (Yé, Burma); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 24 (Java Sea; ?Brazil); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 82 (in key; range), p. 84 (references; localities from which known); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 640 (80 miles northwest of Penang, 40 fathoms; Singapore, 7 fathoms; notes); Treubia, vol. 14, livr. 2, 1933, p. 207 (2 specimens with 11 arms), p. 208 (not included in the *Siboga* collection), p. 213 (north of central Java; off Cape Jabung; near Deli; near Olehleh; notes).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 3 (Macclesfield Bank), p. 4 (French Indochina), p. 5 (range), p. 10 (localities; notes).

Amphimetra laevissima (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Crinoids of the Indian Ocean, 1912, p. 112 (North Borneo).

Antedon mølleri A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 117 (Lütken, MS. = *Amphimetra molleri*).

Alecto mölleri (Lütken, MS.) A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 156 (name found with the type specimen of *Amphimetra* [*Himerometra*] *molleri*).

Amphimetra milberti A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 767 (records from Mergui Archipelago and Borneo); Crinoids of the Indian Ocean, 1912, p. 111 (part; Panay; Zamboanga; Padan Bay; Ceylon); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 24 (part; *Challenger* stations 203, 212).—H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 93 (occurs at Ceylon; from A. H. Clark, 1912).

Amphimetra ensifer Boone, Bull. Vanderbilt Marine Mus., vol. 7, 1938, p. 110 (3.2 miles south-southeast of Pulo Telagra), p. 122 (details of locality; notes; the distribution, references, etc., refer to *A. ensifer*).

Diagnostic features.—The cirri are stout, curved throughout, with 24–50 short subequal segments, which are two to three times as broad as long; dorsal spines are developed before the eighth segment; the arms are up to 150 mm. in length; P_2 has 18–21 segments.

Description.—The centrodorsal is thick discoidal, with a moderately large flat polar area. The cirri are marginal and are arranged in one and a partial second irregular rows.

The cirri are XVI, 34–37, moderately stout, 20 mm. in length. All the segments are subequal, about twice as broad as long, very slightly shorter basally and very slightly longer distally. The sixth and following segments bear small sharp-pointed median dorsal spines. The opposing spine does not reach in height one-third the width of the penultimate segment; it arises from the entire dorsal surface of the penultimate segment, and its blunt apex is median or subterminal in position. The terminal claw is longer than the penultimate segment and is stout and slightly curved.

The IBr series and lower brachials are deep, in close lateral apposition, and laterally flattened against their neighbors. The synarthrial tubercles are prominent, but small.

The 10 arms are about 115 mm. in length.

P_1 is 10 mm. long, slender, and flagellate, with 18 segments. P_2 is 15 mm. long, much stouter than P_1, with 21 segments, of which the first two are not quite so long as broad, the third is about as long as broad, and the remainder are half again as long as broad. P_3 is 11 mm. long, resembling P_2 though slightly more slender. P_4 is 9 mm. long, slightly slenderer than P_3. P_5 and the following pinnules are 9 mm. long, very slender, and flagellate distally. The distal pinnules are 12 mm. long.

Notes.—Chadwick said that a small specimen was obtained at Ceylon Pearl Oyster Fisheries station I, and two fully grown ones at station LVII.

The two specimens from Yé, Burma, are typical, and resemble the type specimen in the Copenhagen Museum collected in the "East Indies." The arms are 100 mm. long. The synarthrial tubercles are small, but very prominent.

Carpenter said that a dozen examples of this species were obtained at King Island in the Mergui Archipelago, half of them from mud flats exposed at spring tide. They were mostly of a light reddish-brown color, but one was more yellowish brown, and another was almost white. Most of the larger specimens have the bases of the rays somewhat flattened laterally, and there is a good deal of variation in the relative sizes of the lower pinnules. P_4 is sometimes considerably shorter than P_3 and sometimes nearly equal to it.

Hartlaub said that the two specimens from Atjeh that he examined at the Leyden Museum differed in their centrodorsals and in their cirri. In one the centrodorsal is hemispherical, but in the other it is much more flattened and broader. The first has the cirri XV, with up to 33 segments, while in the other the cirri are XXV, with about 50 segments. The strong synarthrial tubercles on the articulation between the first two brachials are very characteristic, although they are somewhat variable in their development. The form of the brachials seems also to vary, the brachials in one specimen being markedly shorter than they are in the other. Both are light grayish brown in color. Hartlaub remarked later (1912) that the wallsidedness of the axillaries and first brachials is very marked in the small specimen from Atjeh.

In the specimen from Atjeh that I examined at the Leyden Museum (which was the first of the two mentioned by Hartlaub) the cirri are XXII, 32–34 (usually the latter); the cirrus segments bear sharp dorsal spines from the tenth or eleventh onward. The synarthrial tubercles are developed as in the type specimen of *Amphimetra pinniformis*. The size is slightly less than that of the type specimen at Copenhagen.

The specimen from the Malacca Strait is rather small.

The specimen from 80 miles northwest of Penang has the arms about 145 mm. long. The cirrus segments are somewhat longer than usual.

In the example from Singapore in 13 meters the cirrus segments are also slightly longer than usual.

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One of the two specimens from Singapore recorded in 1909 resembles the type; it is flesh colored, with the perisome brownish. The other is smaller; it is flesh colored, with the perisome of the arms and the bases of the pinnules deep violet exactly as in a specimen of *A. discoidea* at hand from the Philippines. Other specimens from Singapore collected by Svend Gad show the following characters. (1) The arms are 115 mm. long. The cirri are 23 mm. long with 33–35 segments; dorsal spines are developed from the eleventh or twelfth segment onward. (2) The arms are 95 mm. long. The cirri are about 17 mm. long with 24–27 segments; dorsal spines are developed from the seventh-twelfth segment onward. (3) The arms are 100 mm. long. (4) The arms are 80 mm. long. (5) The arms are 75 mm. long.

One of the specimens from off Cape Jabung has 11 arms, one IIBr 2 series being present.

One of the specimens from near Deli also has one IIBr 2 series and 11 arms.

The specimen from the Danish Expedition to the Kei Islands station 101 has the arms 105 mm. long, and the cirri X (with some additional more or less developed ones), 27–30, 20 mm. long. The dorsal pole of the centrodorsal is evenly convex. This is a small specimen with the cirrus segments rather longer than in typical examples, but it seems to belong here. The color is deep purple with the cirri light yellowish.

The specimen from the Danish Expedition to the Kei Islands station 82 has 30–35 cirrus segments.

The specimen from the Danish Expedition to the Kei Islands station 103 is small with the arms 60 mm. long. Dorsal processes are found on the second or third and following cirrus segments.

The largest specimen from Koh Kram has the arms about 80 mm. long.

Miss Lee Boone says of the specimens collected by Mr. Vanderbilt at the Anambas Islands that one is young, another approximately the dimensions of the type (of *A. ensifer*), and the third not quite so large. All three are figured. She says that the centrodorsals are thick and discoidal, with the cirrus sockets close together in two irregular semialternate series. The cirri are XVIII–XX, 30 (except those broken or undergoing regeneration), 20 to 21 mm. long. "These joints have the proportions described in the type [of *A. ensifer*] and are similarly tuberculate in the dorsal line from the tenth to distal articles, except on three cirri, where the tubercles begin, respectively, on the sixth, eighth and ninth articles. These dorsal spines or tubercles are uniformly strong, conical, the proximal ten to twelve being moderately developed, the distal ten being distinctly higher, except when the distal one is yet longer, about subequal; the opposed terminal claw strong, about as long as the diameter of the preceding segment, basally thick and decidedly curved, but nearly straight distally and acuminate." The 10 arms, according to Miss Boone, are about 80 to 85 mm. long, and are unbroken in the largest specimen. None is entire in the second specimen, but the three arms, almost complete, have an average length of 60 mm. each. The XX cirri are each 18–20 mm. long. The disk has a mosaic pavement consisting of small plates. This specimen also has 10 arms. The third specimen, juvenile, has 10 arms of an average length of 30 mm. (with tips broken off), and has the cirri XV, 20–26, the longest about 11 mm. long, "the tubercle spines beginning from the eighth joint distad, these spines being relatively longer and more acuminate in the young crinoid; the subdistal spine in each instance being 1.5 to twice as high as those preceding, and the distal claw of this young specimen, while possessing the characteristic curvature of the species, has the abrupt curvature of the proximal portion continued into the slender distal portion. The synarthrial tubercles are present, but are less pronounced than in the larger specimen [not shown in any of the figures]." The pinnules are said to have the typical structure. Miss Boone says, presumably of the largest specimen, that "the proximal pinnules all have squarish articles and conform to the type description in essentials. P_1 is slender, 7.1 mm. long, with 20 articles; P_2 is 7 mm. long, less slender, with 17 (rarely 18) articles; P_3 is 5 to 5.5 mm. long, like P_2, but with only 16 articles; P_4 is 5 mm. long, consisting of 13 articles, less thick than P_2 and P_3, but not so slender as P_1." Miss Boone said that "Mr. Vanderbilt's field note records these living sea-lilies as brown with yellow markings. Under the microscope the specimens, now preserved nine years in alcohol, show the disk and pinnae as deep purplish brown, the arms and cirri a deep ivory yellow. The apical spines of the pinnae show as crystalline hooks."

Grube described *Comatula laevissima* from North Borneo as follows: This is a strikingly smooth species with 10 arms 74 mm. long consisting of about 150 brachials, and a low convex centrodorsal on the margin of which the cirri are arranged in two rows. The cirri are XVI–XVII, 24–26. The radials are concealed. In one specimen the IBr_2 (axillaries) have mostly a rather sharp dorsal tubercle, and for the most part are syzygial. The brachials have oblique ends and are about as long as broad or broader than long. Syzygies occur between brachials 3+4, 9+10 (or 10+11), 16+17, 23+24 (or 24+25), 30+31 (or 31+32), and 39+40 (or 40+41, or 37+38); the distal intersyzygial interval is 10 or 11 muscular articulations. From brachial 118 onward syzygies become very scarce, or are entirely lacking. P_1 is very slender and short. The following pinnules are much thicker and longer, sometimes up to 10 mm. long, though often much shorter. The number of the segments, which are elongated, is up to 19. One specimen is entirely flesh colored. A second is banded with violet on each brachial. The perisome of the latter is raised into six high blunt soft tubercles of the same length as the anal tube which lie at the base of six adjoining arms.

Professor Schneider, Grube's successor at Breslau, sent the two specimens of *Comatula laevissima* to Dr. P. H. Carpenter for examination. Carpenter said that they agree pretty closely in the characters of their cirri, and in their short brachials; but, as is indicated in Grube's description, their color is altogether different, while one of them has a tubercular junction between the elements of the IBr series and also between the first two brachials, which is altogether absent in the other individual. In the latter, too, the segments of the lower pinnules are sharply carinate. This is not the case in the former, which Carpenter found to be a small individual of what he called *Antedon milberti.* He said that Grube's name will therefore apply only to the other specimen, which he proposed to describe more fully at a future time, though he was never able to do this. This second specimen undoubtedly represents a species of *Decametra*, possibly *D. mylitta* (see Part 4b).

The specimen collected by Dr. Mortensen off Jolo is small and young.

Carpenter's description of *Antedon milberti* in the *Challenger* report was based upon the specimens from *Challenger* stations 203 and 212. He said that the centrodorsal is hemispherical. The cirri are XX–XXX, 25–35, or even nearly 40. Most of the cirrus segments, and especially the lower ones, are broader than long. The middle and outer segments have a more or less distinct dorsal spine.

The radials are almost entirely, or quite, concealed. The IBr_1 are rather sharply convex and rise to a median tubercle at their junction with the wide IBr_2 (axillaries). There is a similar but smaller tubercle on the articulation between the first two brachials. In large specimens the elements of the IBr series and the first two brachials are sometimes slightly wallsided, with straight edges and the margins of the dorsal surface flattened.

The 10 arms are 125 to 150 mm. long and are composed of nearly 300 brachials. The third and next following brachials are smooth, rounded, and nearly oblong, with a tendency to alternating tubercular elevations at their junctions. After the second syzygy the brachials are shortly triangular and slightly overlapping, gradually becoming nearly oblong, but remaining always much broader than long.

Syzygies occur between brachials 3+4 and 9+10 or 10+11, and often also between brachials 14+15 or 15+16. The distal intersyzygial interval is 4 to 20 muscular articulations, usually 9 or 11, the intervals being somewhat longer in the outer part of the arms than in their first third.

P_1 and P_a are about 8 mm. long and consist of some 18 moderately stout segments of which some of the middle ones are longer than broad. The pinnules of the next five or six brachials (fifth to tenth) are somewhat longer and stiffer, with much stouter segments, sometimes the second and sometimes the third pair being the largest. The pinnules of the fourth pair are occasionally much smaller than those of the third, and those of the fifth pair are always much so, after which the length of the segments increases and the later pinnules become long and slender.

The disk is naked and is 10 or 12 mm. in diameter. Sacculi are abundant.

The color in alcohol is dark reddish brown, bleaching to white.

The figures of *Antedon milberti* given in the *Challenger* report represent this species. Carpenter said that in some individuals of what he called *Antedon milberti* (=*molleri*+*tessellata*+*discoidea*) the axillaries and lower brachials have indications of straight lateral edges and of the peculiar wall-sided character that he described as distinctive of the *Basicurva* group, and that this is most marked in the specimen from *Challenger* station 203, which differs from all the other examples of the type that he had seen in showing a considerable portion of the radials externally. Their length is more than half that of the IBr_1, and the tubercles that the latter form with the pentagonal axillaries are less prominent than usual. Both ossicles, and also the first two brachials, have the margins of the dorsal surface flattened, with straight lateral edges, and on some arms this character also extends to the hypozygal of the first syzygial pair (third brachial). But Carpenter remarked that this wallsidedness is always much less distinct than it is in the *Basicurva* group, and in some examples it is scarcely visible at all, while there are no indications of flattening of the sides of P_1.

The specimen from Calbayog, Samar, has the arms 145 mm. long and the cirri XIII, 40, 30 mm. long. The cirrus segments are subequal, all being about twice as broad as long. The dorsal spines begin on the twelfth segment.

A cirrus on the specimen from Port Galera, Mindoro, has 38 segments. Dorsal spines begin on the ninth segment.

Speaking of the specimens from Macclesfield Bank, Annam, Cochinchina, and Cambodia, Gislén said that the cirri in the young are about XV, 26–29, and in the large specimens about XXV, 29–36. The dorsal spines are prominent and pointed. The synarthrial tubercles are well developed. The two specimens from the Macclesfield Bank and Annam are not quite so typical as those from Cochinchina and Cambodia.

In 1909 I wrote that *Amphimetra molleri* is altogether a more delicate species than *A. milberti*, the only other species of the genus *Amphimetra* with very short subequal cirrus segments, and is very readily distinguished by having practically all the cirrus segments, instead of only the outer ones, furnished with dorsal spines. The species here referred to as *A. milberti* is in reality *A. spectabilis*, of which two specimens had recently been received from the *Albatross*, which at that time was working among the Philippine Islands.

Abnormal specimen.—Chadwick noted that in one of the arms of one of the two specimens from Ceylon Pearl Oyster Fisheries station LVII, which was unfortunately detached when found, the fifth brachial beyond the third syzygial pair is an axillary, and in each of the two arms following this axillary the third and fourth brachials are united by syzygy.

Localities.—Suvadiva, Maldive Islands; 79 meters [Bell, 1902; A. H. Clark, 1912, 1918].

Ceylon Pearl Oyster Fisheries station I; west coast of Ceylon; 5 miles west and southwest of Negombo; 22–36 meters; bottom coarse yellow sand with a few dead shells; temperature 25.28° C.; 1902 [Chadwick, 1904; A. H. Clark, 1912, 1918; H. L. Clark, 1915].

Ceylon Pearl Oyster Fisheries station LVII; Gulf of Manaar; outside Dutch Moderagam Paar; 21–66 meters; bottom orbitolites sand, nullipores, and dead corals; 1902 [Chadwick, 1904; A. H. Clark, 1912, 1918; H. L. Clark, 1915].

Investigator; Yé, Burma [A. H. Clark, 1912] (2, U.S.N.M., 35220 [original No. 53B]; I. M.).

Padau Bay, King Island, Mergui archipelago [von Graff, 1887; Bell, 1888; P. H. Carpenter, 1888, 1889; A. H. Clark, 1912, 1918].

Atjeh, western Sumatra; W. Baerts, 1887 [Hartlaub, 1891, 1912 (as Atjih); A. H. Clark, 1911, 1912 (as Atjeh, Burma), 1918] (1, L. M.).

Malacca Strait; H. Koch, March 9, 1872 [A. H. Clark, 1908, 1909, 1912] (1, C. M.).

Eighty miles northwest of Penang; 73 meters; cable repair ship *Patrol*, Eastern and Associated Telegraph Co., through Colonel Grant, Indian Medical Service; taken in May 1923 from a cable laid two years previously [A. H. Clark, 1929] (1, B. M.).

Singapore; 13 meters; December 12, 1898 [A. H. Clark, 1929] (1, B. M.).

Singapore; Svend Gad [A. H. Clark, 1909, 1912, 1918] (9, U.S.N.M., E. 1081; C. M.).

North of central Java (lat. 5°41′ S., long. 109°21′ E.); November 21, 1907 [A. H. Clark, 1933] (1, Buitenzorg Mus.).

Off Cape Jabung, northern coast of southern Sumatra (lat. 1°03′ S., long. 104°35′ E.); July 3, 1908 [A. H. Clark, 1933] (4, Buitenzorg Mus.).

Near Deli, northern Sumatra (lat. 3°40′ N., long. 99°10′ E.); 16–18 meters; June 25, 1908 [A. H. Clark, 1933] (5, Buitenzorg Mus.).

Near Olehleh, at the northwestern end of Sumatra [A. H. Clark, 1933] (1, Buitenzorg Mus.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 101; Java Sea; 49 meters; sand, stones, and sponges; August 5, 1922 (1).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 82; Sunda Straits (lat. 6° 38′ S., long. 105° 21′ E.); 35 meters; sandy bottom; July 30, 1922 (1).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 103; Sunda Straits (lat. 6° 05′ S., long. 105° 42′ E.); 52 meters; shell bottom; August 4, 1922 (1).

Java Sea [A. H. Clark, 1912, 1913] (1, B. M.).

Koh Kram, Gulf of Siam; 55 meters; Dr. Th. Mortensen, March 2, 1900 (10, C. M.).

Anambas Islands; 3.2 miles southsoutheast of Pulo Telaga Island; 60 meters; yacht *Ara*, February 6, 1929 [Boone, 1938].

North Borneo [Grube, 1875; Bell, 1882; P. H. Carpenter, 1883, 1888; A. H. Clark, 1909, 1912].

Dr. Th. Mortensen's Pacific Expedition, 1914–1916; off Jolo (Sulu); about 36–55 meters; sand and coral; March 19, 1914 (1).

Challenger station 212; south of Basilan, Philippines (lat. 6° 54′ N., long. 122° 18′ E.); 18 meters; sand; January 30, 1875 [P. H. Carpenter, 1888; A. H. Clark, 1912, 1918].

Challenger station 203; Off Panay, Philippines (lat. 11° 06′ N., long. 123° 09′ E.); 36 meters; mud; October 31, 1874 [P. H. Carpenter, 1888; A. H. Clark, 1912, 1918].

Calbayog, Samar Philippines; 49–51 meters; Lawrence E. Griffin, September, 1912 (1, M. C. Z., 614).

Port Galera, Mindoro; Lawrence E. Griffin (1, M. C. Z., 680 [part]).

Macclesfield Bank; 50 meters; Dr. C. Dawydoff [Gislén, 1936].

Nha'trang Bay, Annam; littoral; Dr. C. Dawydoff [Gislén, 1936].

Pulo Condor, Cochin China; 0–15 meters; Dr. C. Dawydoff [Gislén, 1936].

Réam, Cambodia; 10 meters; Dr. C. Dawydoff [Gislén, 1936].

"Indian Ocean" [A. H. Clark, 1908, 1909, 1912, 1918] (1, C. M.).

East Indies [A. H. Clark, 1912, 1918] (error for Indian Ocean).

Erroneous locality.—?Brazil [A. H. Clark, 1913] (1, B. M.).

Geographical range.—From the Maldive Islands to the Sunda Islands, the Gulf of Siam, and the Philippines.

Bathymetrical range.—From the shoreline down to 55 (?66) meters.

History.—The first known specimen of this species was one of the two individuals that served Prof. E. Grube as the basis for his description of *Comatula laevissima* in 1875.

In 1887 Prof. Ludwig von Graff described the myzostomes from some specimens from Padau Bay in the Mergui Archipelago, which had been sent him by Dr. P. H. Carpenter identified as *Antedon milberti*, and in 1888 Prof. F. Jeffrey Bell mentioned the occurrence of *Antedon milberti* in the Mergui Archipelago, his record being based on the same specimens.

In 1888 Carpenter published a very exhaustive account of *Antedon milberti*, recording under that name one specimen from *Challenger* station 203 and two specimens from *Challenger* station 212. In his list of localities other than those of the *Challenger*, Padau ("Padan") Bay and North Borneo refer to this species, the others to *Amphimetra discoidea* or to *A. tessellata*. Carpenter had examined the two specimens upon which Grube had based his *Comatula laevissima*, and he found them to represent quite different forms. One of the specimens he identified as *milberti*, and the other he proposed to describe more fully at a future time. Since one of the specimens was referable to *milberti* as he understood it, he said that Grube's name *laevissima* will therefore apply only to the other specimen. In his key to the species of the *Milberti* group *milberti* and *laevissima* are paired. He gave *milberti* as having the radials and lower brachials tubercular and the lower pinnules rounded, while in *laevissima* the radials and lower brachials are smooth and the lower pinnules are carinate. According to Carpenter's indications, taken in connection with Grube's original description, *Comatula laevissima* is undoubtedly a species of *Decametra* (see Part 4b).

In 1889 Carpenter recorded a dozen examples of *Antedon milberti* from King Island in the Mergui Archipelago, which, judged from his figures, are undoubtedly this species. These are the specimens from which came the myzostomes sent to Professor von Graff and which were mentioned by Professor Bell in 1888.

Dr. Clemens Hartlaub in 1891 said that he had examined two specimens of *Antedon milberti* from Atjeh in the Leyden Museum and gave notes on them. One of these was subsequently transferred to the Göttingen Museum.

In 1895 Prof. René Koehler recorded and gave notes upon two specimens identified as *Antedon milberti* belonging to the University of St. Petersburg (Leningrad) and collected on the island of Biliton, north of Java, by M. Korotnev in 1885.

Specimens of this species were recorded from the Maldives by Prof. F. Jeffrey Bell in 1902 under the name of *Antedon laevissima*.

Herbert Clifton Chadwick in 1904 recorded a small specimen of *Antedon milberti* from Ceylon Pearl Oyster Fisheries station I, and two full-grown ones from station LVII.

This species was first differentiated from "*milberti*" and formally described, under the name of *Himerometra molleri*, by me in 1908. The description was based upon a specimen in the Copenhagen Museum from the "Indian Ocean" that had been labeled *Alecto mölleri* by Prof. Chr. F. Lütken. At the same time a second specimen from the Straits of Malacca was recorded.

In my paper on the crinoids of the Copenhagen Museum published in 1909, this species, under the name of *Amphimetra molleri*, was recorded from the "Indian Ocean" (the type specimen), Singapore, and the Straits of Malacca. Notes were given on the specimens from the last two localities, and the species was compared with *A. milberti* (in reality *A. spectabilis*).

In 1911 in a paper on the crinoids of the Leyden Museum I gave notes on the specimen from Atjeh which I examined in that museum.

In a memoir on the crinoids of the Indian Ocean published in 1912 I gave the synonymy of this species and a list of the localities from which it is known. Besides the localities given in the paper on the crinoids of the Copenhagen Museum there are included "East Indies," which is an error for "Indian Ocean," also given, the Maldives and the Java Sea, from specimens in the British Museum, and Atjeh, Burma (error for Sumatra), based on the specimen in Leyden. The following localities listed under *Amphimetra milberti* should have been given under this species—Panay, Zamboanga (based on the *Challenger* specimens), Padan (=Padau) Bay, North Borneo, and Ceylon. In an appendix two specimens are recorded from Yé, Burma, and notes on them are given. The type specimen is said to have come from the "East Indies" instead of from the "Indian Ocean."

In a paper on the crinoids of the British Museum published in 1913 I recorded under the name *Amphimetra molleri* one specimen from the Java Sea and another labeled ?Brazil. Under the name *Amphimetra milberti* I recorded "one typical, but rather small specimen" from *Challenger* station 212 and "one specimen" from *Challenger* station 203. At that time my concept of *milberti* was based upon two specimens recently received from the Philippines, where they had been collected by the *Albatross*, which seemed to agree with Carpenter's figure of *milberti* in the *Challenger* report. These two specimens were subsequently found to be quite different from true *milberti* and were named *spectabilis*. *Amphimetra molleri* is easily mistaken for a rather small *A. spectabilis*, so I have no hesitation in now referring the *Challenger* specimens to *molleri*, especially as *molleri* was subsequently collected by Dr. Th. Mortensen in practically the same locality. The *Alert* specimen in the British Museum that was listed under *Amphimetra milberti* represents in reality *A. tessellata*.

In 1915 Dr. Hubert Lyman Clark gave *Amphimetra milberti* as occurring in Ceylon, basing his statement upon my identification of Chadwick's Ceylon specimens, which was published in 1912.

In my report on the crinoids of the *Siboga* expedition published in 1918 I gave the synonymy of this species and a complete list of the localities from which it is known. These localities are all correct except that East Indies, originally an error for "Indian Ocean," is again included.

Dr. Torsten Gislén in 1936 recorded and gave notes on specimens from Macclesfield Bank, Annam, Cochinchina, and Cambodia.

In 1938 Miss Lee Boone recorded, under the name of *Amphimetra ensifer*, three specimens that had been dredged by William K. Vanderbilt on his yacht *Ara* in the Anambas Islands. Two of these, one large and one small, were figured. From the figures both appear to be quite typical examples of the species.

In the same paper Miss Boone recorded and figured a typical specimen of *Capillaster multiradiata* (as *Comanthus* [*Cenolia*] *samoana*) from the Anambas Islands and an example of *Stephanometra protectus* (as *Lamprometra protectus*) from Bali.

AMPHIMETRA PINNIFORMIS (P. H. Carpenter)

Antedon pinniformis P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 180 (description; Andai, New Guinea).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed); p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 54, 193, 224, 366, 378.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 176 (identity); Mem. Australian Mus., vol. 4, 1911, p. 713 (history), p. 714 (of Bell, 1884=*Oligometrides adeonae*), p. 716 (credited to Australia by P. H. Carpenter, on the basis of Bell, 1884); Crinoids of the Indian Ocean, 1912, p. 31 (of Bell, 1884=

Oligometrides adeonae), p. 34 (of P. H. Carpenter, 1888=*Amphimetra pinniformis*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 86 (of Bell, 1884=*Oligometrides adeonae*).

Oligometra pinniformis A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 126 (listed); vol. 22, 1909, p. 7 (listed), p. 42 (compared with *O. studeri*).

Amphimetra sp. A. H. Clark, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 466 (Holothuria Bank, 15 fathoms; notes).

Amphimetra pinniformis A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 176 (identified as an *Amphimetra*), p. 182 (compared with *A. molleri;* type redescribed); Crinoids of the Indian Ocean, 1912, p. 34 (identity), p. 113 (synonymy; Andai; description of the type); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 25 (Holothuria Bank, 15 fathoms; notes); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 83 (in key; range), p. 89 (references; localities from which known).

Amphimetra planiformis Hawkins, Zool. Rec., vol. 48, 1911 (Oct. 1912), p. 43 (error).

Diagnostic features.—A small species with the arms about 60 mm. long; the cirri, which are curved throughout, have about 25 segments, which are two to three times as broad as long; P_2 has 12 segments.

Description.—The centrodorsal is a convex disk bearing marginal cirri.

The cirri are about XII, 25. The segments are thick, and none of them are longer than broad. Each one from the eighth onward bears a slight dorsal spine which becomes somewhat larger on the penultimate segment.

The radials are partially visible. The IBr_1 are oblong and are almost completely united laterally. The IBr_2 (axillaries) are widely pentagonal, nearly twice the length of the IBr_1, with strong backward projections into the latter, the surfaces of both ossicles rising somewhat toward their junction.

There are 10 arms about 60 mm. long. The first brachials are bluntly wedge-shaped and are closely united laterally. Each has its distal border incised to receive a strong backward projection of the irregularly shaped second brachial. The first syzygial pair (composed of brachials 3+4) is oblong. The next five brachials are broad and nearly oblong with slight backward projections from their proximal edges alternately on opposite sides of the arm. The following brachials are longer and wedge-shaped, becoming more oblong again in the outer parts of the arms.

Syzygies occur between brachials 3+4, and then very irregularly; the second syzygy may be anywhere from between brachials 15+16 to between brachials 22+23, after which there is an interval of 6 to 19 muscular articulations between successive syzygies.

The stoutest pinnules are P_2 and P_b; these consist of about 12 thick segments, which are slightly longer than broad. P_1 and P_a are less stout at the base but about as long as P_3 and P_c, the immediate successors of which are the shortest pinnules on the arm. The following pinnules gradually increase in length, their component segments becoming longer, but more slender. The outer pinnules are longer than the lower ones, and being closely set give the arms a very feathery appearance.

The disk is 5 mm. in diameter and naked. Sacculi are closely set along the pinnule ambulacra.

The color is white, the arms rather scantily clothed with a browner perisome so that the ambulacra are close down on the muscles.

Notes.—I examined this specimen in 1910 and in 1911 wrote that this is a small species of the genus *Amphimetra.* The cirri are XII, 25; the dorsal spines on the outer segments are sharp and long. The cirri are moderately stout, tapering slightly in the distal half, with all the segments subequal, about twice as broad as long, those in the proximal half slightly longer and those in the distal half slightly shorter. The synarthrial tubercles are rather prominent, though small, as in specimens of *Amphimetra discoidea* from Port Molle, Queensland. P_2 is much larger than the small and weak P_1 and is long and stout; P_3 is similar to P_2 and is nearly as long and stout. The following pinnules are small and weak.

The specimen from Holothuria Bank, which is probably of this species, has 10 arms 50 mm. long. The cirri have 22 segments of which the fifth and following bear long dorsal spines and of which the longest are not quite so long as broad.

Localities.—Andai, New Guinea [P. H. Carpenter, 1881, 1883, 1888; Bell, 1882; A. H. Clark, 1908, 1911, 1912, 1918] (1, L.M.).

Holothuria Bank; 27 meters [A. H. Clark, 1911, 1913, 1918] (1, B.M.).

History.—This species was first described by Dr. P. H. Carpenter in 1881 from a single specimen in the Leyden Museum. In the year following Prof. F. Jeffrey Bell gave a specific formula for it which was amended by Carpenter in 1883.

In his key to the species of the *Milberti* group in the *Challenger* report (1888) Carpenter grouped *Antedon pinniformis* with *Antedon serripinna* and *A. carpenteri* under the headings P_a present, P_2 and P_b the largest pinnules, and the cirrus segments short. He said that *pinniformis* has 25 cirrus segments and the first brachials much incised, whereas in *serripinna* and *carpenteri* there are barely 20 cirrus segments and the first brachials are not incised.

This grouping of *pinniformis* with *serripinna* and *carpenteri*, both of which belong to the genus *Oligometra*, led me in 1908 to refer *pinniformis* also to that genus.

In 1911, after studying Carpenter's type specimen in the Leyden Museum in 1910, I referred *pinniformis* to the genus *Amphimetra*, and in the same year I recorded, as *Amphimetra* sp., another specimen from Holothuria Bank, which was definitely assigned to *Amphimetra pinniformis* in 1913.

AMPHIMETRA TESSELLATA TESSELLATA (J. Müller)

PLATE 40, FIGURES 185–187

Alecto tessellata J. MÜLLER, Monatsb. preuss. Akad. Wiss., 1841, p. 184 (description; India); Archiv. für Naturg., 1841, vol. 1, p. 144 (description; India); Abh. preuss. Akad. Wiss., 1841 (1843), p. 224.—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 282 (synonymy; original description quoted; unidentifiable).

Comatula (Alecto) milberti J. MÜLLER, Monatsb. preuss. Akad. Wiss., 1846, p. 178 (description; North America; type brought from New York); Abh. preuss. Akad. Wiss., 1847 (1849), p. 255 (redescribed).—A. H. CLARK, Bull. Mus. Hist. Nat., Paris, 1911, p. 245 (=*Amphimetra milberti*); Crinoids of the Indian Ocean, 1912, p. 30 (same).

Comatula jacquinoti J. MÜLLER, Monatsb. preuss. Akad. Wiss., 1846, p. 178 (description; Ceram); Abh. preuss. Akad. Wiss., 1847 (1849), p. 255 (redescribed).—DUJARDIN and HUPÉ, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 202 (redescribed).—A. H. CLARK, Bull. Mus. Hist. Nat., Paris, 1911, p. 244 (=*Amphimetra milberti*); Crinoids of the Indian Ocean, 1912, p. 30 (same).

Comatula tessellata J. MÜLLER, Abh. preuss. Akad. Wiss., 1847 (1849), p. 251 (redescribed).—DUJARDIN and HUPÉ, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 202 (synonymy; description; mer des Indes).—P. H. CARPENTER, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (unable to place it either in *Antedon* or *Actinometra*).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 30 (identity doubtful).

Alecto milberti LÜTKEN, Grönlands Échinodermata, 1857, p. 60.

Comatula milberti Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 202 (synonymy; description; North America).

Antedon tessellatus Wyville Thomson, Phil. Trans. Roy. Soc., vol. 155, 1865, p. 537 (plating of disk).

Antedon milberti Verrill, Proc. Boston Soc. Nat. Hist., 1866, p. 339 (said to be from North America; not seen).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula).—Bell, Report Zool. Coll. H.M.S. *Alert*, 1884, p. 156 (in part; 1 specimen from Port Molle [remainder are *A. discoidea*]).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 194 (in part; Ceram; Port Molle [part]).—Koehler, Mém. Soc. Zool. France, vol. 8, 1895, p. 418 (Sunda Island); Rev. Suisse Zool., vol. 3, 1895, p. 288 (Bay of Amboina; notes).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1580 (listed; in part).—A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 714 (of Bell, 1884=*Amphimetra milberti* + *A. discoidea* + *Oligometra carpenteri*), p. 715 (of Bell, 1885=*A. discoidea*), p. 716 (credited to Australia by P. H. Carpenter; in reality he refers to *A. discoidea*), p. 719 (of Bell, 1894 = *A. discoidea* + *Oligometra carpenteri*); Crinoids of the Indian Ocean, 1912, p. 30 (of Bell, 1884, as above), p. 34 (of P. H. Carpenter, 1888 = *A. milberti* + *A. discoidea* + *A. molleri*), p. 36 (of P. H. Carpenter, 1889 = *A. milberti* [error; = *molleri*]), p. 37 (of Hartlaub, 1891 = *A. milberti* + *A. molleri*), p. 38 (of Bell, 1894, as above), p. 40 (of Bell, 1902 = *A. producta* + *A. molleri;* of Chadwick, 1904 = *A. milberti* [error; = *molleri*]).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 376 (Sunda Strait), pl. 13, figs. 3, 6.—A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 84 (of Bell, 1884 = *Comatula solaris* + *A. milberti* + *A. discoidea* + *Heterometra nematodon* + *Oligometra carpenteri;* of Bell, 1894 = *A. discoidea* + *O. carpenteri;* B. M., MS. = *A. molleri* + *A. discoidea* + *Heterometra africana*).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 6 (identity).

Antedon milbertii Verrill, Trans. Connecticut Acad. Sci., vol. 1, 1867, p. 341.

Antedon (*Comatula*) *milberti* Pourtalès, Bull. Mus. Comp. Zool., vol. 1, 1869, p. 356 (recorded from America).

Antedon jacquinoti P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula).

Antedon tessellata P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 193 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1580 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 34 (identity doubtful).

Himerometra milberti A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 356 (listed); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 222 (compared with *H. molleri*).

Himerometra tessellata A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 356 (listed).

Amphimetra milberti A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Bull. Mus. Hist. Nat., Paris, 1911, p. 244 (= *Comatula jacquinoti* J. Müller), p. 245 (= *Comatula* [*Alecto*] *milberti* J. Müller), p. 250 (Ceram; detailed description of type of *Comatula jacquinoti*); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 440 (East Indian species occurring south to Port Molle), p. 443 (range on east coast of Australia); Mem. Australian Mus., vol. 4, 1911, p. 717 (known to P. H. Carpenter from Australia), p. 721 (occurs south to Port Molle), p. 734 (in key), p. 767 (synonymy; characters; localities); Crinoids of the Indian Ocean, 1912, p. 30 (= *Comatula* [*Alecto*] *milberti* J. Müller and *C. jacquinoti* J. Müller), p. 31 (= *Antedon milberti* Bell, 1884, in part), p. 34 (= *Antedon laevissima* P. H. Carpenter, 1888, in part; = *A. milberti* P. H. Carpenter, 1888, in part; = *A. laevipinna* P. H. Carpenter, 1888 [error]), p. 36 (= *A. milberti* P. H. Carpenter, 1889 [error]), p. 37 (=*A. milberti* Hartlaub, 1891, in part), p. 40 (= *A. milberti* Chadwick, 1904 [error]), p. 111 (synonymy; summary of published records; range); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 24 (published references to specimens in the B. M.; Port Molle, *Alert; Challenger* stations 203, 212).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 83 (Amboina), p. 94 (comparison with *A. discoidea*), p. 95 (Amboina; characters of the 3 specimens).—A. H. Clark, Rec. Western Australian Mus., vol.

1, pt. 3, 1914, p. 124 (comparison with *discoidea* and *jacquinoti*); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, pp. 223 ff. (detailed account of the distribution in Australia); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 89 (references; identity doubtful; notes).—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 3 (listed), p. 5 (stations 6, 8, 9, 11), p. 26 (description of the specimens), pl. 1, fig. 6.

Amphimetra tessellata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 90 (references; notes; identity doubtful).

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Amphimetra jacquinoti A. H. Clark, Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 124 (comparison with *discoidea* and *milberti* [=*spectabilis*]); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 83 (in key; range), p. 85 (references; detailed description; Stas. 33, 164; additional localities), pp. 271, 273 (listed), pl. 18, fig. 36.—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, pp. 192 and following (range).—A. H. Clark, Temminckia, vol. 1, 1936, p. 302 (Amboina; 0–2 meters; notes).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (French Indochina), pp. 5, 6 (range), p. 11 (locality; notes).—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 35 (Broome; notes).

Heterometra jaquinoti Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 39, footnote (disk reaches to the sixth brachial); p. 41 (details of arms), p. 42 (brachial angles), p. 53 (axillary angle).

Diagnostic features.—The cirri are large and stout, more or less straight proximally, curved distally, with the longest proximal segments varying from nearly twice as broad as long to nearly as long as broad; the cirri are 30–50 mm. long, with 35–47 segments, the earlier sometimes with a broad transverse ridge or paired spines; the arms are 130–300 mm. long, usually 10, occasionally 11 or 12.

Description.—The centrodorsal is thick discoidal, more rarely more or less hemispherical, 6–8 mm. in diameter at the base; the bare dorsal pole is usually broad, about 3 mm. in diameter, and is usually more or less convex, less commonly flat, and sometimes with a small median pit. The outer margin of the dorsal pole is more or less swollen at the bases of the adjacent cirri. The cirrus sockets are arranged in usually two closely crowded alternating rows.

The cirri are XVII–XLIII (usually XX–XXX), 26–47 (usually 35–40), in fully grown individuals 30–50 (usually 35–40) mm. long. The cirri are large and stout, becoming laterally compressed distally. They are commonly stout basally, tapering very appreciably distally; but they may be, in lateral view, of uniform width throughout, or broader in the compressed distal portion than proximally, the last two types being sometimes found in the same individual. The first segment is very short, up to twice as broad as long or even broader, those following gradually increasing in length to the sixth to ninth, which, with a few of those following, are from twice as broad as long to nearly as long as broad, most commonly about half again as broad as long. The segments following are shorter. The longer earlier segments have slightly swollen and more or less prominent distal ends. The cirrus segments are usually subequal, the difference between the longest proximal and the others being slight. Somewhere between the tenth and the twenty-first segment the first dorsal spine appears. The dorsal spines are usually large, broad, and prominent, arising from the entire dorsal surface of the segments, though they may be smaller and lower, confined to the distal portion of the segments and in height not exceeding one-third their width. They are directed obliquely forward, except for the one or two preceding the opposing spine, which are smaller than the others and erect. Occasionally a few of the earlier spines are transversely elongated, or they may be double, there being two spines situated side by side. More rarely the two to eight spines following the first three or four have a longitudinally elongate chisellike crest, or there may be two spines, one in advance of the other. The opposing spine is much larger than the spines on the segments immediately preceding; it is erect and arises from almost the entire dorsal surface of the penultimate segment. The terminal claw is half again as long as the penultimate segment and is slender distally and strongly curved.

The radials are almost or quite concealed; if visible they are smooth and very short, longest in the interradial angles. The IBr_1 are very short and are almost or quite united laterally. The IBr_2 (axillaries) are almost triangular, twice as broad as long, and are not quite in lateral contact. The division series and earlier brachials are usually more or less flattened laterally. More or less strongly developed synarthrial tubercles are usually present. These are conical and sharp and arise abruptly. Rarely IIBr 2 series occur; one IIBr 3 series has been noted.

The 10 (rarely 11 or 12) arms are in full-grown individuals 115 to 300 (most commonly between 150 and 225) mm. long. The first brachials are interiorly united, and the first four brachials are more or less flattened laterally. The brachials to about the tenth are discoidal, smooth, with more or less marked dorsolateral swellings. After the tenth they become more or less triangular, and soon discoidal and extremely short with the finely spinous distal ends slightly produced and overlapping.

Syzygies occur between brachials 3+4, 16+17 to 21+22 (usually 18+19), and 25+26 to 32+33, and distally at intervals of 6–12 (rarely as many as 17) muscular articulations.

P_1 is 5.5–13 (most commonly about 8) mm. long, with 13–22 (usually 13–18) segments. It is markedly smaller than P_2 and P_3 and is more slender distally. It is smooth, and the earlier segments are triangular in cross section. From the third onward the segments, except the distal, are a little longer than broad; the outermost have the distal edge slightly produced. P_2 resembles P_1 but is longer and stouter, 7–16 (usually 9–11) mm. long, with 13–22 (usually 16–20) segments, of which the first is short and squarish and the third and fourth are commonly the longest; the second-sixth are triangular in cross section. P_3 resembles P_2 and is usually of the same length, though sometimes slightly shorter. P_4 is shorter than P_3, with about the same number of, or slightly fewer, segments. The pinnules following are shorter and slenderer, with shorter segments. The distal pinnules are 6.5–9 mm. long, with 16–23 (usually 18–20) segments, of which the first two are broadened and swollen, and those from the ninth onward are long and slender. Some of the lower pinnules may have a trace of carination, usually only on the lower segments.

The disk is about 18 mm. in diameter and may be almost completely covered with a pavement of rather small plates or granules, or may bear small scattered plates.

Color in life.—Dr. H. L. Clark says that the color in life is deep reddish purple, becoming very dull on drying. The arms are more or less marked or banded with white or yellow, but the location and amount of the light color show great diversity; sometimes it is confined to the pinnules or to the dorsal side of the tips of the arms, or to regenerating portions of injured arms.

Notes.—In the three specimens recorded by Gislén from Annam the cirri are about XXX, 29–43 in the young individual, and about XXX, 36–41+ in the two large ones. The longest cirrus segments are about one-third again as broad as long. The dorsal spines, according to Gislén, are smaller and more triangular in profile than those of *A. molleri*.

Hartlaub said that at first sight he had taken the specimen from the Sunda Straits for a 10-armed example of *Antedon ludovici* (=*Craspedometra acuticirra*), with which species it shows the greatest similarity in its dark blackish-brown color, in the striking unevenness of the arm bases, in the form of the centrodorsal, and in the arrangement of the cirri. But a close examination, especially of the pinnules, soon shows the differences.

P_1 is markedly smaller than P_2 and P_3, and its 22 segments are elongated from the third onward. It is four-fifths the length of P_2 and nine-tenths the length of P_3. Its thickness at the base is three-fourths that of P_2, but it tapers so rapidly that in general it is only one-fourth as thick as the following pinnules. The segments of P_2, P_3, and P_4 are elongated, but those of the succeeding pinnules are shorter.

Hartlaub said that corresponding interrelationships of the lower pinnules are shown by a much smaller specimen from Atjeh, Sumatra (=*A. molleri*), which through his intervention the Göttingen Museum received from the Leyden Museum. This specimen differs strikingly from that from the Sunda Straits in its light color. The color of the latter confirms Carpenter's statement that the color (of *milberti*) is dark reddish brown bleaching to white. The color of the dorsal surface of the arms from the arm bases outward passes over from the darkest red-brown very gradually into white.

Hartlaub said it was remarkable that Carpenter did not identify this specimen as *milberti* and did not include the locality Sunda Straits in the *Challenger* report. Hartlaub noted that in many places the axillaries and first brachials have a tendency toward wallsidedness. The photographs published by Hartlaub show that this specimen was a very typical example of this species.

Of the 17 specimens from the Danish Expedition to the Kei Islands station 67, one has 11 arms, a single IIBr 2 series being present. All the other specimens have 10 arms, which in the smallest are only 25 mm. in length.

Of the two specimens recorded by Professor Koehler from Biliton the larger has XX cirri and the smaller XVII only. The dorsal spines are transverse. The larger specimen is very dark in color, purple violet. The smaller has the arms quite colorless and gray, the pinnules alone showing a purple-violet color.

The largest specimen from *Siboga* station 33 has the arms 135 mm. long. The centrodorsal is thick discoidal, with the dorsal pole broad and convex, 7 mm. in diameter. The cirri are XXIV, 44–47 (usually 46–47), 45 to 50 mm. long. The cirri are rather stout basally but taper very appreciably distally. Rather prominent dorsal spines are developed from the thirteenth or fourteenth segment onward. The cirrus segments are subequal, the longest (in the proximal portion) being slightly broader than long. The ends of the segments in the earlier part of the cirri are slightly swollen and prominent. The synarthrial tubercles are small but sharp and prominent. The disk is almost completely covered with a pavement of rather small plates.

Another specimen has the arms 130 mm. long and the cirri XIII, 38–40, from 35 to 40 mm. long. The longest cirrus segments are half again as broad as long. Dorsal spines begin on from the fifteenth to the seventeenth segments.

A third specimen has the arms 115 mm. long and the cirri XIV, 34–41, about 30 mm. long. The longest cirrus segments are half again as broad as long. Dorsal spines begin on from the tenth to the thirteenth segments. On several of the cirri the two to eight spines following the first three or four have a longitudinally elongate chisellike crest, or are longitudinally paired. The color is whitish, becoming purplish toward the ends of the cirri and arms.

The fourth specimen has the arms 115 mm. long and the cirri XVII, 41–43, from 35 mm. to 40 mm. long. The longest cirrus segments are half again as broad as long. Dorsal spines are developed from the twelfth segment onward. The color is purple.

These specimens, like the type specimen from Ceram, have the cirri much less curved than the others I have examined. They were killed by immersion in fresh water, which may account for this condition. The longest proximal cirrus segments have the most produced distal ends.

The specimen recorded by Prof. René Koehler from the Bay of Amboina was of very large size with the arms 200 mm. long. The cirri were XXXI, 40–42. The first brachials were broader and more swollen than usual.

The largest of the three specimens collected by Professor Strubell at Amboina is, according to Dr. Reichensperger, perhaps the largest known specimen. The 10 arms are 300 mm. long. The cirri are about XXX, 28–43, from 35 to 40 mm. long, partly of uniform lateral width, and partly more slender proximally. From the fifteenth to the eighteenth segment onward the segments have prominent dorsal spines which are mostly large, more rarely less well developed. The first segment is short, up to twice as broad as long. From the fourth or fifth onward the segments are more squarish, but soon again become broader, and distally are about half again as broad as long, not counting the spine. The last segment is about as long as broad, or longer than broad. The radials are almost entirely concealed. Very strong synarthrial tubercles are developed on the articulation between the first two brachials. P_1 is 13 mm. long, with 18–20 segments, of which the middle ones are somewhat longer than broad. P_2 is up to 16 mm. long, with 22 segments, of which the middle ones, as in P_1, are somewhat longer than broad. P_3 is 14 mm. long, with about 18 segments, which from the fourth onward are almost regularly longer than broad. There is some variation in the relative size of the lower pinnules, and P_2 is not always the longest. The form of the brachials and to a lesser extent the relative development of the synarthrial tubercles also vary. The disk is 18 mm. in diameter and is very finely granulated.

In the intermediate specimen the arms are 200 to 220 mm. long. The cirri are XLIII, 35–42, and resemble those of the preceding. The synarthrial tubercles are somewhat less strongly developed. The pinnules are somewhat shorter, with fewer (14–18) segments. Reichensperger said that, except for the somewhat less robust cirri, this specimen might have served for the figure given by Carpenter in the *Challenger* report.

In the smallest specimen the arms are 130 mm. long. The cirri are XVII, about 30. The synarthrial tubercles are less strongly developed than in that just preceding. P_1 is about 8 mm. long, with 16–18 segments. P_2 is 11 mm. long, with 18–20 segments. P_3 is equal to P_2, or is slightly shorter. The brachials of this specimen are noticeable for their marked shortness.

All three specimens have some of the lower pinnules with a trace of carination, usually only on the lowest segments. The color of the three specimens in alcohol is blackish brown.

The specimen collected at Amboina by the Danish Expedition to the Kei Islands is large; the cirri have 36–39 segments.

The specimen collected by the *Willebrord Snellius* at Amboina has 11 arms 220 mm. long. One IIBr 2 series is present. The cirri are 40 mm. long, with 43–47 segments.

Müller described *Comatula jacquinoti* as follows: There are 10 arms. The centrodorsal is moderately convex and appears to be entirely covered with cirri. The cirri are XX, 35. Toward the end of the cirri, or much earlier, there is developed dorsally on the segments a spine that—certainly on the forward part of the segment—is directed distally. The cirrus segments are broader than long. The radials are very short. The brachials are short. The intersyzygial interval is 4–7 muscular articulations. P_1 to P_3 or P_4 are stouter than the other pinnules. The color is blackish brown. The expanse approaches 2 feet (which would give an arm length of about 300 mm.). Habitat Ceram.

My notes on the type specimen, which I examined at the Paris Museum, are as follows: The cirri are large and stout, becoming laterally compressed distally. The first segment is very short, and those following progressively increase in length to the eighth or ninth, which is half as long as broad. All the cirrus segments are approximately equal in size. Rather prominent dorsal spines are developed from the twelfth or thirteenth segments onward. There are 10 stout arms. The radials are concealed. The IBr_1 are very short and are almost entirely united with their neighbors. The IBr_2 (axillaries) are almost triangular, twice as broad as long. They are not quite in lateral contact. The synarthrial tubercles are only slightly developed. The brachials are extremely short, with their distal ends slightly overlapping. The pinnules resemble those of the *A. milberti* described by P. H. Carpenter (=*A. molleri*). The color is brownish black.

In the two specimens from *Siboga* station 164 the arms and cirri are slightly stouter than in the specimens from *Siboga* station 33, and the cirri are relatively shorter, with a less-marked production of the distal ends of the segments. In one the arms are about 140 mm. long, and the cirri are XVII, 34, 27 mm. long. The longest cirrus segments are from half again to twice as broad as long. Dorsal spines are developed from the tenth or eleventh segments onward, and the earlier spines are double as described for the specimens from station 33. The color is violet, with the cirri yellow, becoming violet distally in one specimen.

These two specimens closely resemble others at hand from Western Australia. The cirri are proportionately shorter than in those from *Siboga* station 33, and the dorsal and ventral profiles of the individual segments are much less concave, so that they appear much smoother, as in the Western Australian variety.

The largest specimen from the Danish Expedition to the Kei Islands station 11 has 12 arms 205 mm. long. Two IIBr 2 series are developed, one on each of two adjacent rays. The cirri are XIX, 37–46, 40 mm. long. The first segment is very short and those following gradually increase in length, becoming about twice as broad as long on the sixth and half again as broad as long on the last six or eight. The last 23–28 segments have a sharp dorsal spine, which arises from the entire dorsal surface of the segment and is directed obliquely forward, becoming median and almost erect on the two segments preceding the penultimate.

The two other specimens have the arms 150 mm. long. In one the cirri are XVIII, 29–33, 25 mm. long.

The specimen from the Danish Expedition to the Kei Islands station 19*bis* has the arms 170 mm. long. The cirri are XXV, 30–33, from 30 to 35 mm. long. The dorsal pole of the centrodorsal is gently convex.

Of the specimens from the Danish Expedition to the Kei Islands station 19, one has 12 arms, two IIBr 2 series being present. Another has 11 arms about 170 mm. long, a single IIBr 2 series being present; the cirri are XIV (with numerous others partially developed), 39–40, 35 mm. long. A third has 11 arms, with one IIBr 3 series; an extra division series of two ossicles is developed on a first brachial. All the other specimens have 10 arms. In three of them the arms are about 170 mm. long. Two others have the arms 80 mm. and 65 mm. long. One is very small, with the arms 25 mm. long.

Dr. H. L. Clark said that this stiff and rather ungainly comatulid is by no means common at Broome, but he met with it several times while dredging, and one specimen was found at extremely low water in September 1929. The individuals were all adult, with the 10 arms 110–130 mm. long. The cirri are XV–XXX, 28–36. He secured 10 specimens.

As described by Dr. Torsten Gislén the specimen from Mjöberg's station 6 has the cirri XXIX, 28–35. The peripheral cirri have the following numbers of segments: 35, with the dorsal spines beginning on the twelfth; 33, with spines from the twelfth; 33 (a young cirrus); 32, 30, with spines from the eleventh; and 30 (a very young cirrus 3 mm. long); an intermediate cirrus has 30 segments with spines beginning on the twelfth. The cirri of the apical row have the following numbers of segments: 30 (a young regenerating cirrus); 28, with spines from the nineteenth; 31, with spines from the twelfth; and 28 (a very young cirrus without dorsal spines). The 10 arms are 120 mm. long. P_1 is 7.5 mm. long, with 15 segments. P_2 is 9 mm. long, with 16 segments. P_3 is 9 mm. long, with 16 segments. P_4 is 7.5 mm. long, with 15 segments. P_{15} is 7 mm. long. P_a is 6 mm. long, with 14 segments. P_b is 8 mm. long, with 13 segments. P_c is 8 mm. long, with 15 segments. The distal pinnules are 9 mm. long, with 20 segments. This is a pale-colored specimen.

The specimen from Mjöberg's station 8 has the cirri XXIII, 26–35. The peripheral cirri have the following numbers of segments: 35, with spines from the twenty-first; 31, with spines from the nineteenth; 31, with spines from the sixteenth; 29, with spines from the eighteenth; 29, with spines from the seventeenth; and 27 (a very young regenerating cirrus). The cirri of the second (apical) row have the following numbers of segments: 26, with spines from the thirteenth; 27, with spines from the seventeenth; 27, with spines from the thirteenth; 27, with spines from the seventeenth; 28, with spines from the eleventh; 28, with spines from the thirteenth; and 29 with spines from the fourteenth. The 10 arms are 75 mm. long. The brachials are smooth, the proximal ones a little rugged. The first four brachials are a little flattened laterally. The IBr_1 are like the first brachials but are partly fused. P_1 is 5.5 mm. long, with 13 segments. P_2 is 7 mm. long, with 13 or 14 segments. P_3 is of about the same length, with 13 segments. P_4 is up to 6 mm. long, with 12–14 segments. P_a is 4.5 mm. long, with 11 segments. P_b is 6.5 mm. long, with 12 segments. P_c is 8 mm. long, with 13 segments. The distal pinnules are 6.5 mm. long, with 16 or 17 segments. The segments of the pinnules are short. The basal segments are never longer than broad, and are coarse and thick; the distal segments are somewhat longer than broad and, especially in P_c, are slender and thin.

The specimen from Mjöberg's station 9 was thus described by Gislén. The centrodorsal is thick discoidal, with the bare dorsal pole 3 mm. in diameter. The borders of the dorsal pole are somewhat swollen toward the cirrus bases. The cirri are XXIII–XXIX, 26–38, from 20 to 28 mm. long, and are arranged in two rows on the centrodorsal. The dorsal spines may begin anywhere from the ninth to the twenty-first segment. The dorsal spines are short, in height never reaching more than one-third the width of the segments, and arise from the distal portion of the segments. The opposing spine is twice as large as the preceding dorsal spines, is erect, and arises from almost the whole of the dorsal surface of the penultimate segment. The terminal claw is half again as long as the penultimate segment, usually rather slender with a very long point, and is strongly curved. The radials are smooth and very short, longest in the interradial angles. The IBr_1 are laterally united. The elements of the IBr series bear a synarthrial tubercle, as in *Heterometra crenulata*, but arising more abruptly than in that species. The 10 arms are 140 mm. long and are basally closely appressed, though not at all or only very slightly flattened laterally. The first brachials are interiorly united, and there is a synarthrial tubercle on the articulation between the first two brachials. The brachials to about the tenth are irregularly discoidal with dorsolateral swellings, after the tenth becoming triangular. The arms are smooth until about the fiftieth or sixtieth brachial, after which the distal portion of the brachials becomes somewhat produced. The syzygies on two postradial series are as follows: on one arm between brachials 3+4, 10+11, 18+19, 25+26, 34+35, 43+44, and 55+56, and on the other arm between brachials 3+4, 11+12, 18+19, 29+30, 42+43, and 57+58; on one arm between brachials 3+4, 9+10, 21+22, 32+33, and 49+50, and on the other arm between brachials 3+4, 9+10, 16+17, 29+30, 37+38, and 50+51.

P_1 is 5.5–8 mm. long, with 13 (station 8) to 16 (station 11) segments, which are smooth and, except for the distalmost, a little longer than broad. The nine proximal segments are triangular in cross section. The outermost segments have the distal borders somewhat produced. Similar conditions are seen in P_2 and P_3 also. P_2 is 7–10.5 mm. long, with 13 (station 8) to 19 (station 11) segments, of which the first is short and squarish and the third and fourth are the longest; the second-sixth segments are triangular in cross section. Except as noted, P_2 resembles P_1. P_3 is 7–9 mm. long, with 13–17 segments. P_{10} is 5.5 mm. long, with 16 segments. P_{22} is 7.5 mm. long, with 18 segments. P_{75} is 9 mm. long, with 23 segments. The first two segments of the distal pinnules are broadened and swollen. From the ninth onward the segments are long and slender. P_a is 7 mm. long, with 15 segments, corresponding to P_1. P_b is 9 mm. long, with 17 segments.

The color in life was dark red, or bluish violet with the dorsal side of the arms and pinnules and in the outer half the ventral side also pale yellow, the yellow representing regenerated portions.

Although it is not so stated, this description seems to have been based mainly on the specimen from station 9, a few notes being added from the specimens from the other stations.

In the specimen from Mjöberg's station 11 the cirri are XXIV, 27–38. The cirri in the peripheral row have the following numbers of segments: 38; 37, with spines from the sixteenth; 36, with spines from the fifteenth—an old cirrus; 32, with a spine only on the thirty-first—a young cirrus; 32 (a young cirrus) and 32. A very young intermediate cirrus has 28 segments. The cirri in the lower or apical row have the following numbers of segments: 34, with spines from the twelfth; 31, with spines from the eleventh; 31, with spines from the eleventh; 28, with spines from the eleventh; and 27, with spines from the tenth.

In the specimen presumably from the vicinity of Perth, Western Australia, the cirri have 42–47 segments and reach a length of 40 mm. The longest cirrus segments are slightly less than twice as broad as long. The twentieth or twenty-first and following segments bear dorsal spines. The synarthrial tubercles are prominent and conical with the apex sharp, though they are not especially produced.

The six specimens dredged by the *Endeavour* between Fremantle and Geraldton are all large and well developed, with the arms 185 to 195 mm. long. The centrodorsal is 6 to 8 mm. in diameter and is very broad, with a flat or more or less convex dorsal pole, in the center of which there is sometimes to be seen a small pit. The cirri are XX–XXXII, the longest with 37–44 segments, and are 35 to 40 mm. in length. They are moderately stout and are composed of approximately subequal segments of which the longest (in the proximal portion) are half again to twice as broad as long, the distal being slightly shorter.

Müller described *Comatula tessellata* in the following terms: There are 10 arms. The cirri are XX–XV, 45; the cirrus segments are scarcely so long as broad, and the last 24 have small dorsal spines. The radials are very short. The intersyzygial interval is 8–11, rarely as many as 15, muscular articulations. The brachials are very short and are discoidal and imbricating, without a keel. P_2, P_3, and perhaps P_4 are the largest pinnules. The skin of the disk bears small scattered calcareous plates. The color throughout is violet. The size is 1 to 1½ feet (which would mean an arm length of 150–225 mm.). Habitat India. The type specimen was in the Bamberg Museum to which it had been given by Schönlein.

Müller described *Comatula* (*Alecto*) *milberti* as follows: There are 10 arms. The centrodorsal is convex. The cirri are XXV–XXX, 35, the segments in the distal half with a dorsal spine in the middle, which is placed transversely. The radials are extremely short. The brachials are short. The intersyzygial interval is 9–10 muscular articulations. P_2, P_3, and P_4 are the largest. The ventral surface of the disk is soft. The color is blackish brown. The expanse is nearly 2 feet (which would give an arm length of about 300 mm.). Habitat North America.

The type specimen was an alcoholic example in the Paris Museum, which had been received from M. Milbert, of New York.

Localities.—Nha'trang Bay, Annam; littoral; Dr. C. Dawydoff [Gislén, 1936].

Sunda Straits; Capt. G. W. Boot; L. Agassiz, 1859 [Hartlaub, 1912].

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 67; Java Sea (lat. 5°48′ S., long. 106°12′ E.); 38 meters; sand and shells; July 27, 1922 (17).

Biliton (north of Java), Sunda Islands; M. Korotnev, 1885 [Koehler, 1895; A. H. Clark, 1918].

Siboga station 33; Bay of Pidjot, Lombok; down to 22 meters; mud, coral, and coral sand; March 24–26, 1899 [A. H. Clark, 1918] (4, U. S. N. M., E. 479; Amsterdam Mus.).

Bay of Amboina; MM. Bedot and Pictet [Koehler, 1895; A. H. Clark, 1912, 1918].

Amboina; Professor Strubell [Reichensperger, 1913].

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Amboina; breakwater; about 1 meter; February 28, 1922 (1).

Amboina; pier; 0–2 meters; *Willebrord Snellius*, May 6, 1930 (1, L. M.).

Ceram; MM. Hombron and Jacquinot [J. Müller, 1846, 1849; Dujardin and Hupé, 1862; P. H. Carpenter, 1879, 1883, 1888; Bell, 1882; A. H. Clark, 1911, 1912, 1918] (1, P. M.).

Siboga station 164; east of Misool (lat. 1°42′30″ S., long. 130°47′30″ E.); 32 meters; sand, small stones, and shells; August 20, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 11; 20 meters; sand; April 9, 1922 (3).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 19 *bis;* about 20 meters; sand; April 18, 1922 (1).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 19; 20 meters; sand; April 14, 1922 (10).

Port Molle, Queensland; *Alert* [Bell, 1884; A. H. Clark, 1911, 1913] (1, B. M.).

Broome, Western Australia; about 1 mile off jetty; H. L. Clark, August 27 and September 5, 1929 [H. L. Clark, 1938].

Broome; off Gantheaume Point; 4–7 meters; H. L. Clark, August 30, 1929 [H. L. Clark, 1938].

Broome; 9–15 meters; H. L. Clark, June 1932 [H. L. Clark, 1938].

Mjöberg's station 6; Cape Jaubert (south of Broome), Western Australia, 45 miles westsouthwest; 18 meters; July 8, 1911 [Gislén, 1919].

Mjöberg's station 8; Cape Jaubert 45 miles westsouthwest; 18 meters; July 15, 1911 [Gislén, 1919].

Mjöberg's station 9; Cape Jaubert 45 miles westsouthwest; 20 meters; July 15, 1911 [Gislén, 1919].

Mjöberg's station 11; Cape Jaubert 45 miles westsouthwest; 22 meters; July 17, 1911 [Gislén, 1919].

?Vicinity of Perth, Western Australia; Hamburg Southwest Australian Expedition, 1905 [A. H. Clark, 1911, 1912; Hartmeyer, 1916] (1, H. M.).

Endeavour; between Fremantle and Geraldton, Western Australia; 109–183 meters [A. H. Clark, 1914] (6, U. S. N. M., 35110; W. A. M.).

Doubtful and erroneous localities.—India [J. Müller, 1841, 1843, 1849; Dujardin and Hupé, 1862; Wyville Thomson, 1865; P. H. Carpenter, 1879, 1888; A. H. Clark, 1907, 1912, 1918].

North America (probably Western Australia) [J. Müller, 1846, 1849; Dujardin and Hupé, 1862; Verrill, 1866, 1867; Pourtalès, 1869; P. H. Carpenter, 1879, 1883, 1888; Bell, 1882, 1884; A. H. Clark, 1907, 1911, 1912, 1918].

Geographical range.—From Annam, Misool, and Ceram southward to Port Molle, Queensland, and to between Fremantle and Geraldton, Western Australia, and westward to Billiton and the Sunda Straits.

Bathymetrical range.—From the shoreline down to 109 (?183) meters; most of the records are from depths of not more than 20 meters.

History.—There can be no doubt but that the *Alecto tessellata* described by Prof. Johannes Müller in 1841 is the species under consideration, since the description fits this form perfectly and does not apply to any other. The type specimen of *Alecto tessellata* was presented to the Bamberg Museum by Johann Lucas Schönlein, who was a celebrated physician born in Bamberg. It is labeled as having come from India, which in those days was a very indefinite geographical term. Schönlein never visited India or the East Indies, and just how he acquired the specimen is not clear. The type specimen of *Alecto tessellata* has not been reexamined since it was originally described. In the *Challenger* report (1888) Dr. P. H. Carpenter especially mentioned that it was the only comatulid given in the list of species included in that report that he had not personally examined.

In 1846 Müller described *Comatula* (*Alecto*) *milberti* from a specimen presented to the Paris Museum by M. Milbert, of New York, and labeled as having come from North America. Jacques Gerard Milbert was a French painter and naturalist. In 1800 he accompanied, as chief artist, the French expedition in the corvettes *Geographe* and *Naturaliste* sent out under Capt. Nicolas Baudin to explore the Australian seas. François Péron was also a member of this expedition. Captain Baudin died at Mauritius, and the Freycinet brothers succeeded him in command. In 1815 M. Milbert came to America, where he spent seven years in investigations in natural history, later returning to Paris. One of our common northern butterflies, *Vanessa milberti*, is named for him. It is most probable that Milbert collected the type specimen of *Comatula* (*Alecto*) *milberti* on the coast of Western Australia and brought it with him to New York. Therefore it is fairly safe to regard Western Australia as the type locality of this species.

On the same page and immediately following the description of *Comatula* (*Alecto*) *milberti*, Müller described *Comatula jacquinoti*, which was based upon a specimen in the Paris Museum from Ceram labeled as having been collected by Hombron and Jacquinot, though Müller mentioned only Jacquinot. Honoré Jacquinot was a French physician and a brother of Admiral Charles Hector Jacquinot. In the capacity of ship's surgeon he had taken part in Dumont-d'Urville's expedition around the world in the *Zélée* in 1837–1840.

In 1857 Prof. Chr. F. Lütken mentioned *Alecto milberti* as an American species in his account of the echinoderms of Greenland.

Dujardin and Hupé in 1862, under the headings *Comatula tessellata, Comatula milberti,* and *Comatula jacquinoti,* published translations of Müller's original descriptions.

Wyville Thomson in 1865, under *Antedon tessellatus,* mentioned the plating of the disk as described by Müller.

In 1866 Prof. Addison E. Verrill said that he had not seen *Antedon milberti,* which had been described from "North America." Verrill again mentioned the species, as *Antedon milbertii,* in 1867, and in 1869 Count Pourtalès noted that it had been described from North America.

In 1879 Dr. P. H. Carpenter referred *milberti* and *jacquinoti* to the genus *Antedon* as that genus was understood by him, but he was unable to place *Comatula tessellata,* as he knew of no description from which it is possible to obtain any information regarding the position of the mouth or the character of the oral pinnules.

In October 1882 Prof. F. Jeffrey Bell published specific formulas for *Antedon milberti* and *A. jacquinoti,* and in April 1883 Dr. P. H. Carpenter published emended formulas for the same species.

In the report upon the collections of H. M. S. *Alert* published in 1884 Professor Bell recorded *Antedon milberti* from Port Molle, Port Denison, the Prince of Wales Channel, and Torres Strait and said that the rich supply of this species in the *Alert* collection amply justified the doubts that P. H. Carpenter had expressed to him as to the exactness of the locality (North America) ascribed by Müller to this species. He remarked also that this species was well represented in a collection of E. P. Ramsay's, of the Australian Museum, Sydney. Only a single specimen from Port Molle, however, represents the present species, all of the others being examples of the closely allied *Amphimetra discoidea.*

In the *Challenger* report on the comatulids published in 1888 Carpenter made *Antedon milberti* the type of a special group that he called the *Milberti* group, to which he assigned a heterogeneous assemblage of 14 ten-armed species. In the key to these species he inserted *milberti* and *tessellata; milberti* was said to possess cirri with 25–40 segments, while *tessellata* has cirri with 45 segments and an intersyzygial interval of 8–11 muscular articulations. He remarked in a footnote that he had not seen the type specimen of *tessellata.*

In the synonymy of *Antedon milberti* he placed *jacquinoti* and one of the two specimens upon which Grube's *Comatula laevissima* was based (see page 353). The *Antedon milberti* of the *Challenger* report includes the following forms herein regarded as distinct: *Amphimetra tessellata* (Ceram; *Alert,* Port Molle [part]); *Amphimetra molleri* (North Borneo; *Challenger* stations 203 and 212; Padan [=Padau] Bay); and *Amphimetra discoidea* (*Alert,* Port Molle [part]; Port Denison; Prince of Wales Channel; Torres Strait).

Carpenter said that under the name *milberti* he had united the two species that were found by Müller in the Paris Museum with the manuscript names *Comatula milberti* and *Comatula jacquinoti,* which had been given them by Valenciennes. They are each based upon single specimens, which he had carefully examined in 1876 and again in 1880, and the subsequent study of a considerable amount of material obtained by the *Challenger* and the *Alert*, and also by Dr. John Anderson, of the Calcutta Museum, had convinced him that the two types are really identical. He pointed out that Müller hardly ever made any comparison of his species one with another but simply contented himself with descriptions, leaving his readers to determine the real points of difference between his various species. He showed that, as described by Müller, the number of cirrus segments, the characters of the radials and of the brachials, the color, and even the size are the same in the two types; *Comatula milberti* has XXV–XXX cirri, with the spines transverse, while in *C. jacquinoti* there are XXII cirri, with the spines directed forward. In *Comatula milberti* the intersyzygial interval is 9–10 muscular articulations, and P_2, P_3, and P_4 are the largest, while in *C. jacquinoti* the intersyzygial interval is 4–7 muscular articulations, and the first three or four pinnules are stouter than the others. Carpenter said that no one of these characters, or even the combinations of them, can be regarded as of specific value, especially when we remember that each of Müller's species was based upon a single specimen. He recalled that the type specimen of *Comatula jacquinoti* had been obtained at Ceram in 1841 by the expedition of d'Urville in the *Zélée*, while the form Müller described under the specific name of *milberti* had previously received the name from Valenciennes in honor of M. Milbert, of New York, who had given it to the Paris Museum, and it was possibly for this reason that the type was labeled as having come from North America. Carpenter said that under these circumstances Valenciennes, and after him Müller, were perhaps a little predisposed to regard it as distinct from the *Comatula jacquinoti* of Ceram, which Müller described along with it in such nearly identical terms. Carpenter felt quite confident that Milbert's specimen (see page 371) was not obtained anywhere on the Atlantic coast of North America. He had seen nothing like it among the West Indian comatulids dredged by the *Blake*, while the only species of "*Antedon*" found on the Atlantic coast were *Hathrometra tenella* and perhaps *Heliometra glacialis*. All the characters of *milberti*, Carpenter pointed out, are those of the species of "*Antedon*" that inhabit the eastern seas, where more or less similar individuals have been obtained at various localities from the Mergui Archipelago to eastern Australia, and he had little doubt that Milbert's specimen had been brought to America from somewhere within this region. He noted that Verrill referred it to the Caribbean fauna, but with a query, while Dujardin and Hupé, who must have seen it for themselves in the Paris Museum, refer to it as having come from North America. He said that we know nothing respecting any comatulids on the Pacific coast of Central and North America, and he strongly suspected that Milbert's specimen must have been wrongly labeled.

In 1891 Dr. Clemens Hartlaub added Carpenter's *Antedon laevipinna* (=*Amphimetra laevipinna*), which Carpenter had considered as valid in the *Challenger* report, to the synonymy of *milberti*, and said that Carpenter had already recognized the fact that the two were identical, as he had informed him by letter.

In 1895 Prof. René Koehler recorded this species from Biliton in the Sunda Islands, and in another paper from the Bay of Amboina, giving notes on the specimens.

In a first revision of the old genus *Antedon* published in 1907 I referred *milberti* and *tessellata* (accepting the interpretation given them in the *Challenger* report) to the new genus *Himerometra*.

In 1908, under the name of *Himerometra milberti*, I recorded a specimen from *Albatross* station 5100 in the Philippine Islands. This specimen has been responsible for much of the confusion in which the genus *Amphimetra* has been involved. It was identified on the basis of the description and figures given by Carpenter in the *Challenger* report, and for a long time I regarded it as a typical example of *milberti*, basing all my ideas of that species upon it. It is described herein as the type specimen of *Amphimetra spectabilis*.

In a revision of the family Himerometridae published in 1909 *milberti* and *tessellata* were transferred to the new genus *Amphimetra*. Later in 1909 I compared my new species *molleri* with *milberti*, my concept of the latter being based upon the specimen from *Albatross* station 5100.

In 1910 I examined the type specimen of *Comatula jacquinoti* at the Paris Museum and in 1911 published a description of it, referring it to *Amphimetra milberti*. I failed to see the type specimen of *milberti* in the same museum and placed *jacquinoti* in the synonymy of *milberti* on the basis of the comparison made by Carpenter in the *Challenger* report.

In a memoir on the crinoids collected by the Hamburg Southwest Australian Expedition, which was published in 1911, I gave notes under the name *Amphimetra discoidea*, on a specimen presumably from the vicinity of Perth. I said that in this specimen the cirri are stouter than usual, approaching the condition found in *A. milberti* (that is, the specimen of *A. spectabilis* from *Albatross* station 5100), although the individual should undoubtedly be referred to *A. discoidea*. All the additional localities given refer to *A. discoidea* except Port Moresby and Hood Lagoon, New Guinea, which refer to *A. papuensis*.

In a memoir on the recent crinoids of Australia, also published in 1911, I said that the *Alert* collected a specimen of *Amphimetra milberti* (=*tessellata*) at Port Molle, all the other specimens listed in the *Alert* report from Port Molle belonging to *A. discoidea*. I said that *milberti* ranged from the Mergui Archipelago to Borneo and the Philippine Islands and southward to northern Australia. The locality Mergui Archipelago was based upon Carpenter's record (=*A. molleri*); Borneo was based upon Grube's *Comatula laevissima* (=*A. molleri*); and Philippine Islands was based upon the specimen from *Albatross* station 5100 (=*A. spectabilis*).

In a paper on the crinoids of the Berlin Museum, published in 1912, I again mentioned the specimen presumably from the vicinity of Perth under the name of *Amphimetra discoidea*.

In my memoir on the crinoids of the Indian Ocean, published in 1912, I listed *Amphimetra milberti* (including *jacquinoti*), giving the synonymy and a list of the localities from which it is known. The species represented at the localities given are as follows: *Amphimetra laevipinna* (Canton); *Amphimetra discoidea* (Prince of Wales Channel, Torres Strait; Port Molle); *Amphimetra tessellata* (Amboina; Ceram; Port Molle); *Amphimetra molleri* (Panay and Zamboanga [*Challenger* stations 203, 212]; Padan [=Padau] Bay, Mergui Archipelago; North Borneo; Ceylon); *Amphimetra spectabilis* (Philippine Islands). *Alecto tessellata* was given in the unidentifiable list, with a translation of the original description.

In his memoir on the comatulids collected by the United States Coast Survey steamer *Blake*, published in 1912, Dr. Clemens Hartlaub described in considerable detail and figured a specimen, under the name *Antedon milberti*, from the Sunda Strait that had been collected by Capt. G. W. Boot and given to the Museum of Comparative Zoology by Prof. Louis Agassiz in 1859.

In a paper on the crinoids of the British Museum published in 1913 I recorded one specimen of *Amphimetra milberti* from Port Molle, where it had been collected by the *Alert*, one from *Challenger* station 212, and one from *Challenger* station 203. The first represents the present species, but the last two represent *A. molleri;* they were referred to *milberti* because of their resemblance to the specimen from *Albatross* station 5100 (=*A. spectabilis*).

Dr. August Reichensperger in 1913 recorded and described three specimens collected at Amboina by Professor Strubell and commented on the relation between this form and *A. discoidea.*

Under the name *Amphimetra discoidea,* in 1914, I recorded and gave notes upon six specimens dredged by the *Endeavour* between Fremantle and Geraldton, Western Australia. I said that the specimens appeared undoubtedly to be exceptionally large and well-developed examples of *discoidea* but that typically *discoidea* has more slender and more tapering cirri in which the longest proximal segments are very nearly or quite as long as broad, but the distal are shorter, being broader than long. I remarked that in typical *milberti* the cirri are much stouter than they are in these specimens, the segments all being approximately of equal length, though the outer are a trifle longer proportionately, about four times as broad as long. The specimen assumed to represent *milberti* upon which the preceding comparison was based was the specimen from *Albatross* station 5100 subsequently described as the type of *spectabilis.*

Dr. Robert Hartmeyer in 1916 published a note saying that the specimen presumably from Perth is in the Hamburg and not in the Berlin Museum.

In the report upon the unstalked crinoids of the *Siboga* expedition published in 1918, I attempted a complete revision of the species of this genus. The specimen from *Albatross* station 5100 was finally recognized as a distinct form and called *spectabilis,* although it was not formally described. The present species, under the name of *Amphimetra jacquinoti,* was recorded from *Siboga* stations 33 and 164, and notes on the specimens were given. The specimens previously called *discoidea* from ?the vicinity of Perth and from between Fremantle and Geraldton were transferred to this species. *Amphimetra milberti* and *A. tessellata* were included in a list of doubtful species of *Amphimetra* on the basis of their type specimens only, and the former was discussed at considerable length.

In 1919 Dr. Torsten Gislén recorded and gave notes upon four specimens collected by Dr. Eric Mjöberg on the northwest coast of Australia and also discussed the relationships of the species at some length.

In 1921 Dr. Hubert Lyman Clark discussed the range of this form on the coasts of Australia, and in 1924 Dr. Gislén described various structural features on the basis of the material from Mjöberg's collection. In 1936 Dr. Gislén recorded and gave notes on a specimen from Annam. Dr. H. L. Clark in 1938 recorded and gaves notes on 10 specimens collected by himself in 1929 and 1932 in the vicinity of Broome, Western Australia.

AMPHIMETRA TESSELLATA DISCOIDEA (A. H. Clark)

Plate 39, Figures 178, 182; Plate 40, Figure 188

[See also vol. 1, pt. 1, figs. 183, 184 (centrodorsal), p. 235; fig. 336 (cirrus), p. 285; pt. 2, fig. 259 (arm), p. 205; fig. 309 (proximal pinnules), p. 223; fig. 349 (distal pinnules), p. 229; figs. 463, 464 (pinnule tip), p. 266; fig. 791 (ambulacral deposits), p. 372.]

Comatula carinata Guérin-Méneville, Iconographie du règne animal de G. Cuvier, 1828–1837, pl. 1, figs. 2, 2*a*.—Griffith, Cuvier's Animal Kingdom, XII, Mollusca and Radiata, 1834, pl. 8, fig. 2.

Comatula dibrachiata Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 208 (*nomen nudum*).—A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 245 (=*A. discoidea*).

Antedon milberti P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (in part).—Bell, Proc. Zool. Soc. London, 1882, pp. 533, 534 (in part).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 746 (in part).—Bell, Rep. Zool. Coll. H. M. S. *Alert*, 1884, p. 155 (specific formula), p. 156 (Port Molle; Port Denison; Prince of Wales Channel; Torres Strait); Proc. Linn. Soc. New South Wales, vol. 9, 1884 (1885), p. 497 (Port Denison; Port Molle).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 194 (specimens from the Australian localities given; *Challenger* specimens are *molleri*).—Bell, Proc. Zool. Soc. London, 1894, p. 394 (northwestern Australia, 8–15 fms.).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1580 (listed; in part).

Himerometra discoidea A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 225 (*nomen nudum;* compared with *H. ensifer*); Smithsonian Misc. Coll., vol. 52, 1908, p. 215 (description; Port Denison, Queensland; also *Albatross* Sta. 5138).

Amphimetra discoidea A. H. Clark, Proc. U. S. Nat. Mus., vol. 37, 1909, p. 32 (arms compared with those of *A. parilis*); Vid. Medd. Naturh. Forening København, 1909, p. 158 (compared with *A. formosa*); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 2 (possibly the species represented by Guérin-Méneville's fig. 2*a* of *Comatula carinata*, which was possibly drawn from a specimen in the Paris Museum labeled *Antedon milberti* var. *dibrachiata*); Notes Leyden Mus., vol. 33, 1911, p. 182 (synarthrial tubercles compared with those of *Amphimetra pinniformis*); Bull. Mus. Hist. Nat., Paris, 1911, p. 245 (=*Comatula dibrachiata* Dujardin and Hupé), p. 250 (Australia; description of the specimen; possibly served Guérin-Méneville for his figure of *Comatula carinata*); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 436 (northwest Australia, 8–15 fathoms); p. 440 (East Indian species occurring south to Perth and Port Molle), p. 443 (range on the east coast), p. 444 (range on the west coast), p. 459 (localities [New Guinea records are *papuensis*]), p. 466 (association with other species); Mem. Australian Mus., vol. 4, 1911, p. 717 (known to P. H. Carpenter from Australia), p. 721 (occurs south to Port Molle), p. 723 (northwest Australia), p. 734 (in key), p. 766 (synonymy; characters; Port Denison; Port Molle; also Singapore and Philippines; summary of previous records; range; specimen labeled *dibrachiata* in the P. M.); Crinoids of the Indian Ocean, 1912, p. 31 (=*Antedon milberti*, part, Bell, 1884), p. 34 (=*Antedon milberti*, part, P. H. Carpenter, 1888), p. 38 (=*Antedon milberti*, part, Bell, 1894), p. 112 (synonymy; range); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 24 (published references to specimens in the B. M.; localities of specimens in the B. M.).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 82 (Aru Islands), p. 93 (details of localities; abnormal specimen; comparisons), fig. 7, p. 95.—A. H. Clark, Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, pp. 223 ff. (part; detailed account of the distribution in Australia; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 83 (in key range), p. 87 (references; notes; stations 99, 273; additional localities), pp. 272, 275 (listed), pl. 6 (colored), pl. 18, fig. 35.—Gislén, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 4 (synonym of *milberti*).—A. H. Clark, Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 22 (ambulacral deposits).—H. L. Clark, Echinoderm fauna of Torres Strait, 1921, p. 6 (history), p. 21 (range).—Gislén Zool. Bidrag Uppsala, vol. 9, 1924, p. 11(abnormal pinnulation; from Reichensperger).—A. H. Clark, Proc. Biol. Soc. Washington, vol. 47, 1934, p. 11 (Singapore).

Amphimetra formosa A. H. Clark, Proc. U. S. Nat. Mus., vol. 37, 1909, p. 32 (*nomen nudum;* arms compared with those of *A. parilis*); Vid. Medd. Naturh. Foren. København, 1909, p. 156 (compared with *A. mölleri*), p. 157 (Singapore; short description), p. 193 (collected at Singapore by Svend Gad); Mem. Australian Mus., vol. 4, 1911, p. 766 (synonym of *discoidea*); Crinoids of the Indian Ocean, 1912, p. 112 (same).—REICHENSPERGER, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 94 (characters discussed).

Antedon milberti var. *dibrachiata* A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 2 (specimen so labeled in the Paris Mus. possibly the original of Guérin-Méneville's figure).

Comatula (*Antedon*) *milberti* var. *dibrachiata* A. H. CLARK, Bull. Mus. Hist. Nat., Paris., 1911, p. 251 (MS. name by P. H. Carpenter found with a specimen of *A. discoidea* from Australia); Mem. Australian Mus., vol. 4, 1911, p. 767 (comparison with type of *discoidea;* appears to be the original of Guérin-Méneville's figure).

Actinometra brachiolata (B. M., MS.) A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 75 (name found with a specimen of this species in the B. M.).

Diagnostic features.—A medium-sized or rather large form with the cirri moderately stout and straight proximally, becoming more slender and curved distally; the cirri have 34–51 segments of which the longest are about as long as broad and the distal bear short dorsal spines or pointed tubercles; the arms are 110–200 mm. long; prominent sharp-pointed synarthrial tubercles are present.

Description.—The centrodorsal is large, hemispherical or somewhat columnar, with a large convex polar area. The cirrus sockets are arranged in two crowded alternating marginal rows.

The cirri are XVII, 37–45 (usually about 40), 30 mm. long, decreasing very gradually in thickness for the first 8 or 10 segments, then remaining uniform. The first segment is short, about twice as broad as long or rather shorter, and those following gradually increase in length, becoming about as long as broad after the twelfth or sixteenth, and about one-third broader than long in the terminal portion of the cirri. From about the eighteenth segment onward prominent, though small, dorsal spines are developed, which are subterminal in position, becoming terminal on the last two or three segments. The opposing spine is small, median in position, not rising to more than one-third the width of the penultimate segment in height. The terminal claw is somewhat longer than the penultimate segment and is moderately curved.

The radials project slightly beyond the rim of the centrodorsal; their dorsal surface is parallel to the dorsoventral axis of the animal. The IBr_1 are short, oblong, about three times as broad as long. The IBr_2 (axillaries) are rhombic, about twice as broad as long, proximally rising to a low conical tubercle with the IBr_1.

The 10 arms are about 130 mm. in length. The first brachials are wedge-shaped, about two and one-half times as broad as the exterior length, almost entirely united interiorly. The second brachials are irregularly quadrate, rather larger than the first. The first syzygial pair (composed of brachials 3+4) is oblong, two and one-half times as broad as long. The following brachials to the tenth are slightly wedge-shaped, about three times as broad as long, and those succeeding become more obliquely wedge-shaped, somewhat over twice as broad as their greatest length, then gradually shorter and less and less obliquely wedge-shaped, and very short and discoidal after about the proximal third of the arm.

P_1 is small and comparatively slender, 7 mm. long, with 15 segments, all of which are somewhat longer than broad, the first two and the terminal three or four being not quite so long as the others. P_2 is 11 mm. long, stouter than P_1, with 17 segments, of which the first two are about as long as broad and the remainder are slightly longer than broad. P_3 is 10 mm. long, resembling P_2, with 15 segments. P_4 and the following pinnules are 7 mm. long, with 14 segments, P_5 and those succeeding being about as stout as P_1. The distal pinnules are 10 mm. long.

Notes.—The specimen from *Siboga* station 99 is typical, and resembles others at hand from Australia. The color is yellow brown with the cirri and pinnules purple.

The specimen collected by Dr. Mortensen off Jolo has the arms about 150 mm. long.

The specimen from Singapore is slightly smaller than the specimens from the Philippine Islands but agrees perfectly with them. The 10 arms are 110 mm. long, and the cirri are XV, 31–34, from 20 to 25 mm. long. The color is a beautiful deep violet, more or less blotched dorsally with pinkish flesh color.

The specimens collected by the *Albatross* in the Philippines and the one from Singapore I originally considered as representing a distinct species, which I called *Amphimetra formosa.* This species was supposed to differ from *A. discoidea* from Port Denison, Queensland, in having the lower pinnules with shorter segments of which the basal are usually slightly carinate, and the distal have slightly thickened edges vaguely suggesting an approach to the conditions found in *Heterometra crenulata;* the synarthrial tubercles in *formosa* were said to arise more abruptly than they do in *discoidea,* and to be somewhat higher and more prominent. The study of additional material showed that these supposed differences do not hold.

The three specimens collected by the Danish Expedition to the Kei Islands at Amboina are all large. One has the arms 200 mm. long and the cirri XV, 39–42, about 45 mm. long. Another has the arms 195 mm. long and the cirri XVII, 37–39, 40 mm. long. The third specimen is similar to the other two.

Reichensperger recorded seven specimens from Dr. Merton's station 16 in the Aru Islands. The centrodorsal varies from flat to hemispherical; if it is flat there is sometimes a small tubercle in the center. The cirri are XV–XXVIII (the last in the largest specimen), 32–42, from 30 to 35 mm. long. From the fifteenth-eighteenth segment onward a prominent dorsal spine is developed. The earliest segments are very short and broad, but from the third onward the relative length increases up to the fifteenth-eighteenth segments, which are almost squarish, though always somewhat broader than long. The relative length of the segments then decreases, and usually toward the end of the cirri again increases so that the antepenultimate segment is approximately squarish while the last is visibly longer than broad. The radials are slightly visible. The IBr_1 are at least three times as broad as long. The IBr_2 (axillaries) are at the most twice as broad as long, rhombic, rising on the articulation with the IBr_1 to a very stout sharp tubercle. An almost equally stout tubercle is found on the articulation between the first two brachials. There are in all cases 10 arms, which are 120 to 150 mm. long. The form of the brachials is as described and figured by Carpenter in the *Challenger* report (=*A. molleri*). P_1 is about 8–9 mm. long and is composed of 15 or 16 segments of which the two first are almost squarish and the remainder are longer than broad. P_2 is about 11–13 mm. long, with 17–20 segments, and is somewhat stouter than P_1 and P_3. P_3 is 9–10 mm. long, with 16 segments. P_2 and P_3 have the two lowest segments almost squarish as in P_1, and the remainder longer than broad. The pinnules following decrease slowly in length and in the number of their segments (14–10) and again increase in the distal portion of the arms. The lower pinnules are to a greater or lesser extent keeled. The diameter of the disk is 10–12 mm. When dried the disk is usually prominently and often rather coarsely granulated. The anal tube is less conspicuously granulated. The color in life of the dorsal side was white. The cirri more or less extensively, and the ambulacral grooves, were violet, this color sometimes extending onto the sides of individual arms. In alcohol the color is grayish white and dark violet.

One of the seven specimens from this station is very small with the arms only about 35 mm. long. It was found attached to one of the larger individuals. The cirri are XVII, 17–20, up to 10 mm. long. The fourth segment is already approximately squarish, and those following are almost without exception markedly longer than broad. P_1 has 10 and P_2 has 12 or 13 segments. The relative length of the individual segments is not quite the same as it is in the pinnules of the larger specimens. The synarthrial tubercles are much less developed than in the latter. But there can be no doubt that all seven specimens represent the same species.

A specimen from Merton's station 10 has the arms 120 mm. long, but the cirri relatively short, not over 20 mm. long, with about 35 segments. The synarthrial tubercles are moderately developed. The pinnules are relatively stout. P_1 is composed of about 14 segments and is up to 8 mm. in length. P_2 is composed of 16 segments and is 10 mm. long. P_3 has 16 segments and is 8 mm. long. In none of the other specimens of this species did Reichensperger find such varying proportions in the individual cirrus segments. For instance, there are two P_1 in which both of the first two segments are much longer than broad, while the third segment is squarish. On the other hand, there are P_1 with squarish basal segments, the second segment somewhat longer than broad, the third much longer, the fourth abruptly much broader than long, and the fifth and following again markedly longer than broad. There is no trace of regeneration in these pinnules. The color in life of this specimen, as also of two others from the same station, was white, with the ambulacral grooves and the whole of the cirri violet.

A specimen from between Batu Kapal and Meriri was in life colored as the preceding. The arms are 70 mm. long. Synarthrial tubercles are only weakly developed. The cirri are only XII, arranged in a single row. Most of the lower pinnules and the anal tube are in process of regeneration. The disk is very prominently and coarsely granulated.

A large specimen from Merton's station 12 has the arms about 140 mm. long, and the cirri up to 35 mm. long with 35–43 segments, which in the relation of length to breadth are almost half way between *discoidea* and *milberti* (=*tessellata*); they can in no way be described as "slender." In the relation to body size and to arm length they are at least as stout as the cirri of similar specimens of true *milberti* (=*tessellata*). P_1 is relatively shorter than in the other specimens, and P_2 is not over 9–10 mm. in length. The color is the same as in the others.

A typical example from *Siboga* station 273 has the arms 115 mm. long and the cirri XV, 32–34, 22 mm. long. The longest cirrus segments are slightly broader than long. The disk is almost completely covered with plates. From this station there are 12 other similar specimens, and two small and immature examples. These specimens exactly resemble others at hand from Queensland and from northwestern Australia. The cirri are comparatively slender and taper distally.

Of the eight specimens from Torres Strait in the British Museum seven are brownish yellow, with the cirri deep purple narrowly banded with white at the articulations, and the last is entirely purple.

Of the 12 specimens from Port Denison in the collection of the Australian Museum one has the cirri XXII, 46, 30 mm. long; in another the cirri are XX, 36–49, 30 mm. long; in a third they are XXIII, 43, 40 mm. long; and in a fourth they are XXII, 42–45, 30 mm. long. These and five others closely resemble the type specimen, which also came from Port Denison, and six additional specimens, three of which are large and beautiful examples of the species, in the British Museum. They show no tendency toward the curiously abrupt type of synarthrial tubercle or toward the short-segmented proximal pinnules characteristic of the form from the Philippine Islands and Singapore that I have called *formosa.* Three other large and well-developed specimens from Port Denison in the Australian Museum have the cirri about XX, 46–51, from 30 to 37 mm. long. These three all show the abrupt synarthrial tubercles and the short-segmented proximal pinnules of *formosa* in more or less perfected form.

One of the *Alert* specimens from Port Molle in the British Museum is a fine example of the species. The two specimens from Port Molle in the Australian Museum have the cirri about XX, 39–42, 30 mm. long. Both of these specimens have synarthrial tubercles resembling those in the type specimen of *formosa.*

The two specimens from northwestern Australia in the British Museum are slaty gray, purplish ventrally.

The three specimens from Western Australia are typical.

The specimen in the Paris Museum labeled *Comatula* (*Antedon*) *milberti* var. *dibrachiata* exactly resembles the type specimen in the United States National Museum. The cirri have 26 or 27 segments.

The specimen from the Danish Expedition to the Kei Islands station 101 has the arms about 100 mm. long. It is flesh colored, with the pinnules and ventral surface deep purple.

The seven small specimens from the Danish Expedition to the Kei Islands station 75 appear to be young examples of this form. The dorsal spines on the cirri of some individuals begin as early as the fourth or fifth segment.

Reichensperger said that in *discoidea* the carination on the earlier segments of the lower pinnules is in general more marked than it is in *tessellata,* although there is individual variation in this feature. The general appearance of the pinnules in cross section is thus somewhat more slender and more rounded in *tessellata* than it is in *discoidea.*

Abnormal specimens.—A 4-rayed individual was secured by the *Siboga* at station 273. The missing ray appears to be the anterior. Except for the absence of one of the rays this example seems to be quite similar to the others from this station.

In a medium-sized specimen from the Aru Islands described by Reichensperger two pinnules instead of a new arm have regenerated on a stump formed by the breaking off of an arm between the fifth and sixth brachials. Reichensperger regards this as proof of equivalent developmental potentiality in arm and pinnule buds. He noted that this peculiarity has already been noticed in *Comatella nigra,* which is a slip for *C. stelligera* (see Part 3, p. 106).

Remarks.—Whether *discoidea* should be recognized as a species distinct from *tessellata*, or as a geographical race, or perhaps merely as a form, is at the present time simply a matter of personal opinion. Although when they are typically developed *tessellata* and *discoidea* are very different in appearance, they certainly intergrade. The ranges of the two types overlap, though generally speaking *tessellata* is characteristic of the region from the Sunda Islands to the Moluccas and southward along the coast of Western Australia, while *discoidea* is equally characteristic of the region from the Philippines to Singapore and eastern and northern Australia as far as the Aru Islands.

Dr. August Reichensperger said in 1913 that the similarities between typical *tessellata* and the Australian *discoidea* are so great, while on the other hand the differences, which have to do only with the relative width of the cirrus segments and a few cirrus segments, are so slight and so variable, that one can scarcely regard the two forms as species; at most they can be considered as local varieties. He said that he kept *discoidea* distinct from *tessellata* only to avoid increasing the present (1913) confusion in the taxonomy of the comatulids. He remarked that the small specimen from Merton's station 16 seemed to him to cast doubt on the possibility of establishing new species on the basis of differential characters furnished by the cirri. His view is that as the cirrus segments change the relation of length to breadth during growth the cirri afford specific characters of only very limited value. He also noted that the number of pinnule segments is not fixed, and synarthrial tubercles are much less strongly developed in small than in large individuals. He believed that, in view of the detailed descriptions given of their specimens by Carpenter and by Hartlaub, supplemented by his study of the large specimen of *tessellata* from Amboina, the most reasonable assumption is that the various so-called species really represent a kind of developmental series.

In the present state of our knowledge the identification of comatulids in very many cases is practicable only if adults are available for study. This is particularly true in the case of species with more than 10 arms.

But the fact that a small individual of *discoidea* differs widely in cirrus and pinnule characters and in the relative development of the synarthrial tubercles from an adult is no indication that it would not be distinguishable from a small individual of *tessellata* in the same stage of development. In many different animal types growth changes are as far reaching as they are in the crinoids, and in not a few groups that are much better known than the comatulids accurate identifications are possible only if adults are available.

Dr. Torsten Gislén (1919) entirely agreed with Dr. Reichensperger that it is incorrect to maintain *discoidea* and *tessellata* as distinct species on the ground of the somewhat different cirrus segments.

Localities.—Takao, Formosa (Taiwan); Dr. Fred. Baker, December 3–4, 1914 [A. H. Clark, 1912, 1918] (1, U.S.N.M., 34497).

Port Galera, Mindoro, Philippines; Dr. Lawrence E. Griffin (2, M.C.Z., 680).

Albatross station 5432; in the vicinity of eastern Palawan; Corandagos Island (N. W.) bearing N. 30° E., 5. 7 miles distant (lat. 10°37′50″ N., long. 120°12′00″ E.); 93 meters; sand; April 8, 1909 (1, U.S.N.M., 36010).

Albatross station 5131; Sulu (Jolo) Sea, off western Mindanao; island off Panabutan Point bearing N. 20° E., 0.4 mile distant; 49 meters; green mud and coral sand; February 6, 1908 (1, U.S.N.M., 36029).

Albatross station 5132; Sulu Sea, off western Mindanao; island off Panabutan Point bearing N. 15° W., 0.3 mile distant; 47 meters; green mud and sand; February 6, 1908 (1, U.S.N.M., 35246).

Albatross station 5138; in the vicinty of Jolo (Sulu); Jolo light bearing S. 19° E., 2.5 miles distant (lat. 6°06′00″ N., long. 120°58′50″ E.); 35 meters; sand and coral; February 14, 1908 [A. H. Clark, 1908, 1909, 1911, 1918] (1, U.S.N.M., 35201).

Philippine Islands [A. H. Clark, 1912, 1918]. This refers to the 4 preceding *Albatross* stations.

Dr. Th. Mortensen's Pacific Expedition, 1914–16; off Jolo; about 22 meters; sand and coral; March 17, 1914 (1); about 27 meters; March 21, 1914 (1).

Siboga station 99; anchorage off North Ubian (lat. 6°07′30″ N., long. 120°26′00″ E.); 16–23 meters; lithothamnion bottom; June 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Singapore; Svend Gad [A. H. Clark, 1909, 1911, 1912, 1918] (1, C.M.).

Singapore; 1899 [A. H. Clark, 1934] (1, Raffles Mus.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Amboina; about 2 meters; stony bottom; February 9, 1922 (3).

Aru Islands; Dr. H. Merton's station 10; north of Penambulai; 8 meters; stony bottom; April 2, 1908 [Reichensperger, 1913; A. H. Clark, 1918].

Aru Islands; Dr. H. Merton's station 12; near Mimien; 15 meters; coarse sand; April 8, 1908 [Reichensperger, 1913; A. H. Clark, 1918].

Aru Islands; Dr. H. Merton's station 16; near Udjir; 10–14 meters; coral rock and sand; April 16, 1908 [Reichensperger, 1913; A. H. Clark, 1918].

Aru Islands; Dr. H. Merton; between Batu Kapal and Meriri; 10 meters; March 30, 1908 [Reichensperger, 1913; A. H. Clark, 1918].

Siboga station 273; anchorage off Pulu Jedan, eastern coast of the Aru Islands; pearl banks; 13 meters; sand and shells; December 23–26, 1899 [A. H. Clark, 1918] (16, U.S.N.M., E. 472; Amsterdam Mus.).

Prince of Wales Channel; 13–16 meters; *Alert;* sand [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1913, 1918] (14, B. M.).

Torres Strait; 18 meters; sand; *Alert* [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1918] (8, B. M.).

Port Denison, Queensland [Bell, 1885; P. H. Carpenter, 1888; A. H. Clark, 1911, 1918]. Same [A. H. Clark, 1911, 1918]; (12, Austr. M.; U.S.N.M., 35182, 36161). Same [A. H. Clark, 1908, 1911, 1918] (1, U.S.N.M., 25453). Same; *Alert* [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1913, 1918] (6. B. M.). Same; *Alert,* 5 meters [A. H. Clark, 1911, 1918]. Same; *Alert;* 5–7 meters [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1918].

Port Molle, Queensland [Bell, 1885; P. H. Carpenter, 1888; A. H. Clark, 1911, 1918]. Same [A. H. Clark, 1911, 1918] (2, U.S.N.M., 35080; Austr. M.). Same; *Alert* [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1913, 1918] (3, B. M.). Same; *Alert;* 22–36 meters [Bell, 1884; P. H. Carpenter, 1888; A. H. Clark, 1911, 1913, 1918] (1, B. M.).

Holothuria Bank; 27 meters [Bell, 1894; A. H. Clark, 1911, 1918]. Same; 27 meters [A. H. Clark, 1913, 1918] (1, B. M.).

Northwestern Australia; 15–27 meters [Bell, 1894; A. H. Clark, 1911, 1913, 1918] (2, B. M.).

Western Australia [A. H. Clark, 1911 (also as West Australia), 1913, 1918] (3, B. M.).

Australia; MM. Péron and Lesueur [Guérin-Méneville, 1828–1837; Griffith, 1834; Dujardin and Hupé, 1862; A. H. Clark, 1911, 1918] (1, P. M.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 101; Java sea; 49 meters; sand, stones, and sponges; August 5, 1922 (1).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 75; Sunda Straits (lat. 6°10′ S., long. 105°44′ E.); 40 meters; sand and shells; July 29, 1922 (7).

No locality [A. H. Clark, 1913] (2, B.M.).

Geographical range.—From Formosa (Taiwan) and the Philippines to Singapore, and southward to Port Molle, Queensland, and Holothuria Bank, northwestern Australia.

Bathymetrical range.—From the shoreline down to 93 meters; nearly all the records are from depths of less than 30 meters.

History.—The figure of *Comatula carinata* published by Guérin-Méneville in his "Iconographie du Règne Animal" (1828–1837) and republished by Griffith in 1834 undoubtedly represents this form.

In 1862 Dujardin and Hupé gave a list of 12 names that they found with specimens in the Paris Museum. One of these names was *Comatula dibrachiata.*

Dr. P. H. Carpenter did not distinguish this form from *milberti.* It was included by him in *milberti* when he assigned that species to the genus *Antedon* in 1879. Bell's specific formula for *milberti* published in 1882 and Carpenter's emendation of it published in 1883 both included *discoidea.*

In the *Alert* report published in 1884 Bell recorded *Antedon milberti* from Port Molle, Port Denison, the Prince of Wales Channel, and Torres Strait. Except for a single specimen from Port Molle, all Bell's specimens represented the present form.

In the *Challenger* report on the comatulids published by Carpenter in 1888 the *Alert* localities just given that were included under *Antedon milberti* refer to *discoidea,* with the single exception noted.

In 1894 Prof. F. Jeffrey Bell published a list of the echinoderms collected by P. W. Bassett-Smith, Surgeon, R. N., while attached to H. M. S. *Penguin* during a surveying trip in northwestern Australia. Professor Bell gave no specific localities for the specimens, saying merely that the chief localities were Holothuria Bank, Magnetic Shoal, Cossack Island, and Baudin Island (lat. 14°08′ S., long. 125°36′ E.). He said that *Antedon milberti* was obtained in 8–15 fathoms. The present species was secured only on Holothuria Bank.

In a paper published on December 10, 1908, I described *Himerometra ensifer* (=*Amphimetra ensifer*) and compared its arms with those of *H. discoidea,* the latter name appearing as a *nomen nudum.* In another paper published on December 23, 1908, *Himerometra discoidea* was described in detail from a specimen from Port Denison in the United States National Museum, which had many years before been secured from the Australian Museum, and was recorded also from *Albatross* station

5138 in the Philippines. It was remarked that this is probably the species that has been recorded from Port Denison as *Antedon milberti*, but the relatively slender cirri with comparatively long segments contrast sharply with the very stout cirri of *milberti* (in reality *spectabilis*, mistaken for *milberti*=*tessellata*), which have exceedingly short segments.

In a revision of the family Himerometridae published in 1909 *discoidea* was referred to the genus *Amphimetra*, and later in the same year it was compared with *A. formosa*.

In 1911 I wrote, in a paper on the crinoids of the African coasts and also in a paper on the crinoids of the Paris Museum, that one of the figures (2*a*) of *Comatula carinata* published by Guérin-Méneville appears to be a species of *Amphimetra*, and that there is a specimen of *A. discoidea* (labeled by P. H. Carpenter *Antedon milberti* var. *dibrachiata*) in the Paris Museum from which I suspected it had been drawn.

In a paper on the crinoids of the Leyden Museum published in 1911 the synarthrial tubercles of Carpenter's *Antedon* (=*Amphimetra*) *pinniformis* were compared with those of *discoidea*.

In a memoir on the crinoids collected by the Hamburg Southwest Australian Expedition in 1905, published in 1911, a specimen of *discoidea* (in reality *tessellata*, see page 360) was recorded from the ?vicinity of Perth, and the known localities for *discoidea* were given (see page 369).

In a memoir on the crinoids of Australia published in the same year specimens of *discoidea* were recorded from Port Denison and Port Molle, and notes on them were given. I mentioned *Amphimetra formosa* from Singapore and the Philippine Islands, comparing it with the specimens of *discoidea* from Port Denison, and gave the Australian localities from which *discoidea* is known, and also the range of the species (see page 380). Guérin-Méneville's figure and the specimen upon which it was probably based were again mentioned.

In my memoir on the crinoids of the Indian Ocean published in 1912 I gave the synonymy and range of this form. In the synonymy *Amphimetra formosa* was included without comment, and in the range Formosa (Taiwan) was mentioned on the basis of a specimen recently received by the United States National Museum.

Dr. August Reichensperger in 1913 recorded and gave notes on a number of specimens collected by Dr. H. Merton in the Aru Islands and discussed in detail the status of this form, which he regarded as at best but a local variety of *milberti* (=*tessellata*). In the same year I recorded 12 lots of specimens in the British Museum, 7 from the *Alert* collection previously recorded by Bell (1884), 2 from the collection of the *Penguin*, also previously recorded by Bell (1894), 1 from Western Australia, and 2 without locality, one of which was labeled *Actinometra brachiolata*.

In my memoir on the unstalked crinoids of the *Siboga* expedition published in 1918, I recorded specimens from *Siboga* stations 99 and 273 and gave a complete synonymy, together with a complete list of the localities from which this form is known. In the synonymy the references to Grube's *laevissima* should have been placed under *molleri*. None of the specimens included under *Himerometra anceps* (1908) are really this form. The specimen presumably from the vicinity of Perth recorded as *discoidea* in 1911 was transferred to *jacquinoti* (=*tessellata*), as were those from between Fremantle and Geraldton recorded as *discoidea* in 1914. All the localities given are correct with the single exception of North Borneo, which refers to Grube's *Comatula laevissima* (=*molleri*).

In 1919 Dr. Torsten Gislén said that he entirely agreed with Reichensperger's opinion that it is incorrect to maintain *milberti* (=*tessellata*) and *discoidea* as species on the basis of the somewhat different cirrals.

AMPHIMETRA TESSELLATA PAPUENSIS A. H. Clark

[See vol. 1, pt. 2, figs. 37, 38 (radial pentagon), p. 20.]

Amphimetra discoidea (part) A. H. Clark, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 549 (specimens from Port Moresby and Hood lagoon, New Guinea).

Amphimetra schlegelii (part) A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 111 (New Guinea; Tonga; Fiji).

Amphimetra papuensis A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 25 (Tonga and Fiji; characters of the cirri; also Hood lagoon and Port Moresby, New Guinea); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 83 (in key; range), p. 89 (references; localities from which known).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 48 (extends to Tonga).

Diagnostic features.—A medium-sized or rather small form with the cirri moderately stout and more or less straight basally but becoming slender and recurved distally, with 30–34 segments of which the longest are usually about as long as broad and the short outer bear prominent long, slender, and sharp dorsal spines; the arms are up to 110 mm. in length; synarthrial tubercles are obsolete; the proximal pinnules are slender, with 17 or 18 segments.

Description.—The centrodorsal is discoidal, rather thin, with the small irregular dorsal pole flat and finely pitted. The cirri are arranged in two closely crowded and somewhat irregularly alternating rows.

The cirri are XVII, 30–34, about 30 mm. long. The first segment is very short, three to four times as broad as long, and those following slowly increase in length to from the fifth-eight to the ninth-eleventh segments, which are usually about as long as broad or slightly broader than long but vary from half again as broad as long to slightly longer than broad. The distal segments are between half again and twice as broad as long, the terminal gradually lengthening again so that the last two or three are about as long as broad. The cirri are moderately stout basally, tapering very slowly in the proximal half but more rapidly in the distal half, so that the width of the terminal segments is not much more than half that of the basal segments. From the ninth-thirteenth segment onward long, sharp, and conspicuous dorsal spines are developed.

The radials are rather long, twice as long laterally as in the median line, with the distal border strongly and regularly concave. The sides of the radial pentagon are parallel. The IBr_1 are about three times as long as the radials in the median line, rather short, between five and six times as broad as long, with the distal border slightly and very broadly concave in the middle and at the ends straight or very slightly and broadly curved downward. The lateral portions of the dorsal surface are flattened or slightly and broadly swollen, and the lateral edges are throughout in lateral apposition and are rather broadly flattened. The IBr_2 (axillaries) are low, between two and one-half and three times as broad as long, about twice as long as the IBr_1, triangular with the lateral angles rather broadly truncated and the corners broadly rounded. The extreme lateral portions of the dorsal surface are slightly flattened or slightly and very broadly swollen. The sides of the IBr_2 and of the first brachials and of the second brachials as far as the base of P_1 are flattened. Synarthrial tubercles are very slight or absent.

The 10 arms are about 110 mm. long. The first brachials are wedge-shaped, nearly twice as long exteriorly as interiorly, with the interior sides united for from two-thirds to nearly the whole of their length. The second brachials are slightly larger and somewhat more obliquely wedge-shaped, more than twice as long exteriorly as interiorly. The first syzygial pair (composed of brachials 3+4) is oblong, short, rather more than three times as broad as long. The next six brachials are practically oblong, about four times as broad as long. Those following are very obliquely wedge-shaped, almost triangular, more than twice as broad as the longer side, soon becoming less and less obliquely wedge-shaped and in the outer half of the arm very short and oblong with the distal ends very slightly produced.

Syzygies occur between brachials 3+4 and 9+10, again from between brachials 14+15 to between brachials 17+18, and distally at intervals of usually 8 muscular articulations.

P_1 is 9 mm, long, with 18 segments, slender and tapering evenly to the tip. The first segment is about twice as broad as long, the second is nearly as long as broad, the third is longer than broad, and those following increase in length so that the distal are half again as long as broad and the last two or three are twice as long as broad. The second-fourth or -fifth have a slight carinate ridge armed with numerous minute spines on the side toward the arm tip. The sixth and following have the half of the distal edge toward the arm tip slightly produced and everted, and dentate; on the segments succeeding this dentate production of the distal edge soon involves all of the distal edge, though always remaining most developed on the side toward the arm tip.

P_2 is 9.5 mm. long, with 18 segments, and is stouter than P_1, with proportionately very slightly shorter segments, though otherwise similar to it. P_3 is about as long as P_2 or slightly shorter and is similar to it or very slightly stouter. It has 17 or 18 segments. P_4 is 6 mm. long, with 15 segments, resembling P_3 but very slightly more slender basally and tapering more rapidly.

The distal pinnules are slender, 6.5 mm. long, with 17 segments, most of which in lateral view are from half again to twice as long as broad.

The color in alcohol is purple, darkest on the ventral perisome and on the cirri.

Notes.—The specimen described above is one of those from Hood Lagoon, New Guinea. The specimens from this locality are more or less intermediate between typical *papuensis* and *discoidea*, though nearer the former. No examples of what should be regarded as typical *papuensis* are at present available.

In the small specimen in the British Museum labeled Tonga and Fiji the cirri have 25 segments of which the outer are more spiny than usual. It resembles very closely the specimens from Hood Lagoon and Port Moresby.

Remarks.—This form is simply an extreme development of *Amphimetra tessellata discoidea* from which it differs in being of more slender and delicate build with more slender cirri, which have longer and more prominent dorsal spines, and in having the synarthrial tubercles only very slightly developed. It appears to intergrade with *discoidea* just as *discoidea* intergrades with *tessellata*.

Localities.—Port Moresby, New Guinea [A. H. Clark, 1911, 1912, 1918] (1, Austr. M.).

Hood Lagoon, New Guinea [A. H. Clark, 1911, 1912, 1918] (11, U.S.N.M., 35244).

Tonga and Fiji [A. H. Clark, 1912, 1913, 1918] (1, B. M.).

Geographical range.—From Tonga and Fiji to southeastern New Guinea.

Bathymetrical range.—Littoral.

History.—In a list of the localities at which *Amphimetra discoidea* has been found, which I published in 1911, the specimens on the strength of which Port Moresby and Hood Lagoon are included really represent this form.

In my memoir on the crinoids of the Indian Ocean (1912) these two localities, and in addition Tonga and Fiji, are given under *Amphimetra schlegelii* with which, because of its slender cirri with long dorsal spines, this form was at the time supposed to be synonymous.

In a paper on the crinoids of the British Museum published in 1913 a specimen labeled Tonga and Fiji was recorded under the name of *Amphimetra papuensis.* This name here appeared for the first time, but the only characters given were those mentioned above under "Notes."

In the *Siboga* report on the unstalked crinoids (1918) *papuensis* was included in the key to the species of *Amphimetra,* and the synonymy and known localities were given.

AMPHIMETRA ENSIFER (A. H. Clark)

PLATE 38, FIGURES 172–174; PLATE 39, FIGURE 179

[See also vol. 1, pt. 1, fig. 86 (lateral view), p. 141; fig. 256 (centrodorsal), p. 255; fig. 337 (cirrus), p. 285; fig. 474 (radial pentagon), p. 361; pt. 2, figs. 39, 40 (radial pentagon), p. 26.]

Himerometra ensifer A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 225 (description; Singapore).

Amphimetra ensiformis A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed; *nomen nudum*).

Amphimetra ensifer A. H. CLARK, Vid. Medd. Naturh. Foren. København, 1909, p. 158 (Singapore; specimens described), p. 159 (compared with *A. schlegelii*), p. 193 (collected at Singapore by Svend Gad); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 17 (compared with *A. laevipinna*); Crinoids of the Indian Ocean, 1912, p. 113 (synonymy; Singapore); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 83 (in key; range), p. 88 (references; locality); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 640 (Singapore; 7 fathoms).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 45.

Diagnostic features.—A medium-sized or rather small form with the synarthrial tubercles extravagantly developed and produced; the cirri are 23–30 mm. long, with usually 30–35 segments of which the longest are usually slightly longer than broad; the arms are 80–120 mm. long.

Description.—The centrodorsal is thick discoidal. The cirrus sockets are arranged in two closely crowded and irregular more or less alternating rows.

The cirri are XV–XX, 30, from 20 to 25 mm. in length. The first segment is very short, and those following gradually increase in length to the sixth, which is about as long as broad. The next five or six segments are slightly longer than broad, and in those succeeding the length very gradually decreases so that the distal segments are about one-third again as broad as long. The tenth and following segments have well-developed dorsal spines.

The disk is completely covered with a pavement of small plates.

The synarthrial tubercles between the elements of the IBr series and the first two brachials are extravagantly developed, as in *Perometra diomedeae*, giving the animal a very characteristic appearance.

The 10 arms are 80 mm. long and resemble those of *A. discoidea*.

The segments of all the proximal pinnules are about as long as broad. P_1 is 7 mm. long, very slender, with 20 segments. P_2 is 7 mm. long, stouter than P_1, with 17 segments. P_3 is similar to P_2 but is only 5 mm. long, with 16 segments. P_4 and the following pinnules are less stout than P_2 and P_3 though stouter than P_1, 5 mm. long, with 13 segments.

The color in alcohol varies from nearly white to dark brown, with the perisome darker. The cirri of the lighter specimens are usually purplish.

Notes.—Of the four specimens recorded in 1909 one has the arms 90 mm. long and the cirri XVII, 30–33, from 20 to 23 mm. long. It is white, with the perisome brownish purple and the cirri becoming light purplish distally. Another is similar but is yellow-brown. A third has the arms 80 mm. long and the cirri XIV, 30–33, from 23 to 27 mm. long; in color it is brownish white. The fourth is smaller and is light bluish gray.

Other specimens not previously recorded show the following characters: (1) The arms are about 95 mm. long, and the cirri are XIX, 33–36, from 22 to 24 mm. long; the dorsal pole of the centrodorsal is convex, 3.5 mm. in diameter. (2) The arms are 95 mm. long, and the cirri are XVI, 28–34, from 22 to 24 mm. long; the dorsal pole of the centrodorsal is flat, 4 mm. in diameter. (3) The arms are 115 mm. long and the cirri are XVI, 29–33, 25 mm. long; the dorsal pole of the centrodorsal is convex, 4.0 to 4.5 mm. in diameter. (4) The arms are 120 mm. long, and the cirri are XVI, 34–39, 25 mm. long; the dorsal pole of the centrodorsal is convex, 3.5 mm. in diameter. (5) The arms are 95 mm. long, and the cirri are XIV, 38–40, from 25 to 30 mm. long; the dorsal pole of the centrodorsal is slightly convex, 3.5 mm. in diameter. (6) The arms are 80 mm. long. (7) The arms are 75 mm. long. (8) The arms are 40 mm. long.

Locality.—Singapore; Svend Gad [A. H. Clark, 1908, 1909, 1912, 1918] (63, U.S.N.M., 36197, 36260, 36261, E. 1083; C.M.). Same, 13 meters; December 12, 1898 [A. H. Clark, 1929] (7, B. M.).

History.—This species was first described as *Himerometra ensifer* in 1908 from a specimen from Singapore in the collection of the Copenhagen Museum that had been collected by the Danish consul at that port, Svend Gad.

In a revision of the family Himerometridae published in 1909 this species was referred to the new genus *Amphimetra*, being listed through error as *Amphimetra ensiformis*. Later in 1909 four additional specimens were recorded from Singapore, and notes on them were given.

It was listed in my memoir on the crinoids of the Indian Ocean (1912) and in my report upon the unstalked crinoids of the *Siboga* expedition (1918), and in both volumes the synonymy and habitat were given. In the *Siboga* report it was included in a key to the species of *Amphimetra.*

Seven additional specimens from Singapore belonging to the British Museum were recorded in 1929.

AMPHIMETRA LAEVIPINNA (P. H. Carpenter)

PLATE 38, FIGURES 175, 176

Antedon laevipinna P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 502 (description; Canton, China); Proc. Zool. Soc. London, 1882 (1883), p. 746; *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 206 (in key).—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 81 (discussion; considered a synonym of *milberti*).—HAMANN, Bronns Klassen und Ordnungen des Tier- Reichs, vol. 2, Abt. 3, 1907, p. 1580 (listed).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 479 (listed); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (=*Amphimetra laevipinna*); Crinoids of the Indian Ocean, 1912, p. 34 (of P. H. Carpenter, 1888=*Amphimetra milberti*).

Himerometra schlegelii A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 223 (10-armed specimen).

Amphimetra milberti (part) A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed); Crinoids of the Indian Ocean, 1912, p. 111 (record from Canton, China).

Amphimetra schegelii (part) A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 7 (listed).

Amphimetra schlegelii (part) A. H. CLARK, Vid. Medd. Naturh. Foren. København, 1909, p. 158 (10-armed specimen); Crinoids of the Indian Ocean, 1912, p. 111.

Amphimetra laevipinna A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (=*Antedon laevipinna* P. H. Carpenter), p. 15 (compared with *A. schlegelii* and with *A. philiberti;* northern representative of the *discoidea* group), p. 17 (=*milberti*, in part, of P. H. Carpenter, 1888, and Hartlaub, 1891;=*schlegelii*, in part, of A. H. Clark, 1908, 1909; Canton, China; detailed description of the type and of another from an unknown locality); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range in east Asia); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (Malayan species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 83 (in key; range), p. 88 (references; localities from which known).—MORTENSEN, Hong Kong Nat., Suppl., No. 3, 1934, p. 5 (Canton).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 48 (extends to southern Japan).

Amphimetra schleegelii GISLÉN, Kungl. Svenska Vet.-Akad. Handl., vol. 59, No. 4, 1919, p. 28 (comparison with *milberti* [=*tessellata*]).

Diagnostic features.—A small species with the arms 70–95 mm. long and the cirri XI–XVII, 25–35, 23 mm. long, with the longest segments about as long as broad. The synarthrial tubercles are prominent, though broad and blunt.

This species is closely related to *A. ensifer* from which it differs most obviously in its broad and blunt, instead of produced, synarthrial tubercles.

Description.—The centrodorsal is a thick convex disk, bearing marginal cirri.

The cirri are XVII, 25–35. The segments are thick, the first five or six short and broad and their immediate successors are about as long as broad. A faint dorsal spine appears on about the tenth segment and increases in size rather rapidly, the segments also shortening somewhat. In the later segments the spine is slightly smaller and projects forward rather less strongly. The opposing spine is larger than any of the preceding spines.

The radials are visible and are longer at the sides than in the median line. The IBr_1 are broadly hexagonal and are partly united laterally. The IBr_2 (axillaries) are almost triangular and are but little longer than the IBr_1. The elements of the IBr series rise toward the middle of the articulation between them into an elevation which stands up as a prominent tubercle.

The 10 arms are 75 mm. long. They are in close apposition with their neighbors on each side. The first brachials are broadly pentagonal and are partially united by their inner sides, which are somewhat shorter than the outer. The second brachials are irregularly quadrate with their inner sides projecting beyond the edges of the preceding segments. The outer sides of both the first and second brachials are somewhat flattened laterally, and there is a synarthrial tubercle on the articulation between them just as in the case of the elements of the IBr series. The first syzygial pair (composed of brachials 3+4) is short and oblong. The next few brachials are short, strongly rounded dorsally, and nearly oblong, with slight backward projections alternately from the inner and outer sides of their proximal edges. The following brachials are short and sharply wedge-shaped; they are at first considerably broader than long but narrow rather quickly and also commence to overlap so that the middle and later brachials are almost saucer-shaped.

Syzygies occur between brachials 3+4 and 9+10, and distally at intervals of 7–13 (usually 10 or 11) muscular articulations.

None of the pinnules are specially distinguished. P_1 is slender and consists of about 15 smooth cylindrical segments. P_a is shorter and slenderer. P_2 is about as long as P_1 but it is stouter, composed of thicker segments, which are all very smooth. The basal segments of the next two pairs of pinnules are still rather thick, after which they decrease in size and the pinnules increase very slowly in length, never becoming especially long and consisting of smooth cylindrical segments.

The disk is about 6 mm. in diameter, and the anal tube is plated. Sacculi are closely set along the pinnule ambulacra.

The color is light brown, with purplish bands.

Notes.—The preceding description is adapted from Carpenter's original description of the type specimen in the Hamburg Museum. I examined this specimen in 1910 and made the following notes upon it: The 10 arms are about 95 mm. long. The cirri are XI, 27–33, 23 mm. long, moderately slender. The longest proximal segments are from slightly broader than long to about as long as broad, and the short outer segments are about twice as broad as long. Long, sharp, and prominent dorsal spines are developed from the tenth or eleventh segment onward. The cirri have a very slight distal taper. The synarthrial tubercles are prominent, but broad and blunt and not produced as in *A. ensifer.*

I was able to compare the type specimen directly with the 10-armed specimen from Japan in the Copenhagen Museum, which had been included in the original description of *Himerometra* (*Heterometra*) *schlegelii* in 1908, and found that in size, as in other characters, there is the closest agreement.

A specimen without locality in the Hamburg Museum closely resembles the type specimen in every particular, though it is slightly smaller, the arms being 70 mm. long.

Localities.—Canton, China; Werner [P. H. Carpenter, 1881, 1883, 1888; Hartlaub, 1891; A. H. Clark, 1912, 1913, 1915, 1918; Gislén, 1919; Mortensen, 1934] (1, H. M.).

"Japan" [A. H. Clark, 1908, 1909, 1912, 1913, 1915, 1918] (1, C. M.).

No locality; C. Eberstein [A. H. Clark, 1912, 1913, 1915, 1918] (1, H. M.).

Geographical range.—The habitat of this species is somewhat uncertain, but is probably southern Japan or somewhere in the area covered by the southerly extension of the southern Japanese fauna. The specimen without locality carried the same data as a specimen of *Eudiocrinus variegatus* (see page 157), a species known only from southern Japan. As a locality Canton means little, since it is merely a center for the assembling and distributing of curios from over a wide area, though of course mainly from the more or less immediate vicinity. The type specimens of *Heterometra variipinna* (see page 278) and of *Comantheria grandicalyx* (see Part 3, p. 515) were also labeled Canton.

History.—This species was originally described by Dr. P. H. Carpenter in 1881 from a specimen in the Hamburg Museum labeled Canton. In 1883 he published a specific formula for it. In the *Challenger* report on the comatulids (1888) he inserted it in a key to the six species of "*Antedon*" that did not seem to fit into any of the groups he had established for 10-armed species. In this key it was paired with (*Oligometrides*) *adeonae*, both possessing P_1 and P_a and having the lower pinnules tolerably equal; according to Carpenter *laevipinna* has 25–35 spiny cirrus segments and a distal intersyzygial interval of 10 or 11 muscular articulations, while *adeonae* has 20 cirrus segments without spines and a distal intersyzygial interval of 4 or 5 muscular articulations.

Hartlaub wrote in 1891 that he had examined two specimens of *Antedon milberti* from Atjch (in reality *molleri*) in the Leyden Museum and also the type specimen of *laevipinna* in the Hamburg Museum and that *laevipinna* is identical with *milberti*. He said further that Carpenter had also realized this and had had the kindness briefly to confirm his conclusion in a letter. He remarked that the Hamburg specimen, according to Carpenter, is noteworthy in having the segments of the pinnules of the second and third pairs not so thick nor so long as usual. After comparing the type specimen of *laevipinna* directly with one of the specimens from Atjeh he found that this observation was entirely justified. That *Antedon laevipinna* proves to be a synonym of a previously known species Hartlaub said was the more acceptable since it is among those species that Carpenter was not able to place in any one of his groups.

I at first accepted Hartlaub's dispostion of *laevipinna*, but in 1910 I examined the type specimen in the Hamburg Museum and was convinced that it could not be specifically identical with the specimen from Atjeh (=*molleri*), which I saw in the Leyden Museum. In 1912 I published some notes on the type of *laevipinna* and recorded a second specimen without locality in the Hamburg Museum. At the same time under the heading *Amphimetra schlegelii* I redetermined the 10-armed specimen included in the original description of *schlegelii* in 1908 as *Amphimetra laevipinna*.

In my memoir on the crinoids of the Indian Ocean (1912) *Antedon laevipinna* is given as a synonym of *Amphimetra milberti*, following Hartlaub.

In my memoir on the unstalked crinoids of the *Siboga* expedition (1918) the synonymy and localities of *Amphimetra laevipinna* are given, and the species is included in the key to the species of *Amphimetra*.

Dr. Torsten Gislén in 1919 discussed the relationship between *milberti* (*tessellata* as understood herein) and *schlegelii* as represented by the 10-armed specimen, arriving at the conclusion that the latter is probably a good species because of the relatively large number of pinnule segments combined with the small arms.

Family MARIAMETRIDAE A. H. Clark

Palmata group (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 223; Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 305 (species collected at Mergui).—Hartlaub, Nova

Acta Acad. German., vol. 58, No. 1, 1891, p. 13 (diagnosis; range; 30 species), p. 35 (diagnosis; discussion; key to the species); Bull. Mus. Comp. Zool., vol. 27, 1895, p. 137 (structural position); Mem. Mus. Comp. Zool., vol. 27, 1912, p. 409.—A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1907, pp. 127, 130 (new species); Smithsonian Misc. Coll., vol. 50, 1907, p. 344 (characters differentiating this group not diagnostic), p. 355 (*Himerometra*, gen. nov., includes part of species), p. 357 (*Cyllometra*, gen. nov., includes part of species).

Himerometridae (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135; Proc. U. S. Nat. Mus., vol. 34, 1908, p. 211 (includes *Oligometra*, *Cyllometra*, *Himerometra*, and *Pontiometra*).

Mariametrinae A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (includes *Mariametra* and *Dichrometra*); Mem. Australian Mus., vol. 4, 1911, p. 728 (raised to family rank).

Stephanometrinae A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (includes *Oxymetra* and *Stephanometra*); Mem. Australian Mus., vol. 4, 1911, p. 728 (raised to family rank); Journ. Washington Acad. Sci., vol. 5, 1915, pp. 126–134 (bathymetrical range; phylogenetic and paleontological significance).

Mariametridae A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 649 (referred to the Oligophreata); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 438 (1 genus and 4 species in Australia); Mem. Australian Mus., vol. 4, 1911, p. 717 (proportion of species of this family in the Australian fauna as known to P. H. Carpenter), p. 720 (proportion of species of this family in the Australian fauna), p. 725 (*Mariametra* and *Selenemetra* absent from Australia), p. 730 (in key), p. 731 (1 genus in Australia); Crinoids of the Indian Ocean, 1912, p. 6 (exclusively confined to the East Indian region; number of genera and species), p. 11 (represented in the Ceylon region by *Dichrometra* and *Selenemetra*), p. 12 (represented in the Red Sea by *Dichrometra;* in the southeast African region by the same), p. 22 (distribution in detail; down to 59 fathoms), pp. 47, 52 (in keys), p. 57 (key to the included genera); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 141 (revised; considered as including the genera of Pontiometridae, except *Epimetra*, which is assigned to the Colobometridae; 2 new genera, *Liparometra* and *Lamprometra*, described); Bull. Inst. Océanogr., Monaco, No. 294, 1914, pp. 7–8 (relation to temperature).—Alexander, Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 108.—A. H. Clark, Journ. Washington Acad. Sci., vol. 4, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges), p. 582 (relation to temperature of habitat); vol. 5, 1915, pp. 126–134 (bathymetrical range; phylogenetic and paleontological significance); American Journ. Sci., vol. 40, 1915, p. 67 (detailed philosophical discussion of bathymetrical range); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, p. 223 ff. (detailed account of the distribution of Australian species); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, p. 45 ff. (phylogenetic study); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 97 (key to the included genera); Univ. Iowa Stud. Nat. Hist., vol. 9, No. 5, 1921, p. 14 (not represented in the West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 3.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 9, 74; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 19, 42, 55, 78, 84, 89, 99, 213, 230, 231, 235, 240, 280, 287; Vid. Medd. Dansk. Naturh. Foren., vol. 83, 1927, pp. 22, 23.—H. L. Clark, Rec. South Australian Mus., vol. 3, 1928, p. 368.—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 640; Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 557; Treubia, vol. 14, livr. 2, 1933, p. 213.—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 20, 25; Temminckia, vol. 1, 1936, p. 302.—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 12.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, pp. 88, 100, 103.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 35.—Boone, Bull. Vanderbilt Marine Mus., vol. 7, 1938, p. 120.

Stephanometridae A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 649 (referred to the Oligophreata); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 438 (1 genus and 1 species in Australia); Mem. Australian Mus., vol. 4, 1911, p. 720 (proportion of species of this family in the Australian fauna), p. 725 (*Oxymetra* absent from Australia), p. 730 (in key), p. 731 (1 genus in Australia); Crinoids of the Indian Ocean, 1912, p. 6 (number of genera in the East Indian region; number also found in the Atlantic; number represented by closely allied genera in the Atlantic; number exclusively East Indian; number of East Indian species), p. 9 (absent from Australia), p. 10 (absent from Japan), p. 11 (represented in Ceylon by *Stephanometra*), p. 12 (represented in the southeast African region by the same), p. 13 (East Indian and corresponding West Indian genera), p. 22 (distribution in detail; down to 35 fathoms; all the large species confined to the Philippine Islands, the Moluccas, and the Solomons; represented in the Atlantic by *Analcidometra* [in reality belongs to the Colobometridae]), pp. 47, 51 (in keys), p. 57 (key to the included genera); Journ. Washington Acad. Sci., vol. 4, 1914, pp. 559–563 (correlation of geographic and bathymetrical ranges), p. 582 (relation to temperature of habitat); American Journ. Sci., vol. 40, 1915, p. 67 (detailed philosophical discussion of bathymetrical range); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, p. 223 and ff. (detailed account of the distribution in Australia); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 93; Univ. Iowa Stud. Nat. Hist., vol. 9, No. 5, 1921, p. 14 (not represented in the West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 3.—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924 p. 10 (P_2), pp. 19, 42, 55, 78, 84, 89, 99, 231, 280, 287; Arkiv för Zoologi, vol. 19, No. 32, 1928, p. 6; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 20, 25; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 11.

Stéphanomètres A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 252.

Mariamètres A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 253.

Diagnosis.—A family of the superfamily Mariametrida in which the elements of the IBr series are united by synarthry, and the arms are always more than 10 in number, the IIBr series being always 2. The perisome of the disk is most commonly naked, but sometimes there are more or less conspicuous scattered thick plates or concretions, which may be more or less contiguous, especially along the ambulacral grooves, or the disk may be almost or quite completely plated (see Part 2, p. 228). The lateral perisome of the pinnules usually contains simple, more rarely forked or multiradiate, spicules, between which and the edge of the pinnulars there may be small straight spicules or small rods; but calcareous deposits are frequently wholly absent (see Part 2, pp. 241 [*Stephanometra*] to 244).

Geographical range.—Southern Japan from the Oki Islands in the Sea of Japan to Tokyo Bay, the Bonin Islands, the Philippine, Pelew, Caroline, Marshall, and Hawaiian Islands, Samoa, Fiji, the Tonga Islands, New Caledonia, northern Australia south to Cape Hillsborough, Queensland, and the Abrolhos Islands and possibly Perth, Western Australia, and the Lesser Sunda Islands, and westward to Madagascar and the east coast of Africa from the Red Sea south to Durnford Point, Zululand.

Bathymetrical range.—From the shore line down to 245 (?421) meters.

Remarks.—The 27 forms included in the family Mariametridae fall into seven genera—*Oxymetra*, *Stephanometra*, *Pelometra*, *Liparometra*, *Lamprometra*, *Dichrometra*, and *Mariametra*.

The structural range within the Mariametridae is very small when compared with that within the Zygometridae and Himerometridae, and especially within the Colobometridae.

The genus *Oxymetra*, with its long many-jointed cirri and characteristic lower pinnules, is rather sharply separated from the other genera of the family, and bears a considerable superficial resemblance to the genus *Pontiometra* of the Colobometridae. The other six genera are all closely related, and young or immature individuals of the included species are sometimes not easily determined generically.

The species of the genus *Lamprometra* is exceedingly variable in regard to the proximal pinnules and the cirri, though these always keep within well-defined limits, and there is never any difficulty in distinguishing it from species in other genera.

Gislén said that it seemed to him rather unfortunate to characterize the genera within the family Mariametridae on the basis of the relationships between the relative lengths of the proximal pinnules, P_1, P_2, and P_3, as has been done in the case of *Liparometra, Lamprometra*, and *Dichrometra*, which surely are very closely allied. It cannot be denied that these three genera are very closely related and that certain individuals are not always readily placed generically merely by reference to the proximal pinnules. Dr. Hubert Lyman Clark also wrote that he was somewhat inclined to question the desirability of recognizing these three very closely allied genera. Yet *Liparometra, Lamprometra*, and *Dichrometra* appear to represent definite generic types, which are most obviously and readily differentiated from each other by the interrelationships between the proximal pinnules when these are fully and typically developed.

The species of Mariametridae are especially characteristic of the region from southern Japan to Polynesia, northern Australia, and east Africa. Two genera, *Stephanometra* and *Lamprometra*, occur from the Philippines and Polynesia to northern Australia and east Africa; one, *Dichrometra*, ranges from southern Japan to the Admiralty Islands and New Guinea and westward to east Africa; one, *Liparometra*, is found from southern Japan to the Tonga Islands and the Lesser Sunda Islands; one, *Mariametra*, occurs from southern Japan to Amboina and the Lesser Sunda Islands; one, *Oxymetra*, occurs from the Philippines to New Britain and westward to Ceylon, and one, *Pelometra*, is known only from Amboina.

Like the species of the family Himerometridae, the species of Mariametridae are especially characteristic of the littoral and sublittoral regions. Of the seven included genera, five occur along the shore line. The two that have not as yet been taken in shore collecting are *Mariametra*, occurring in 40–153 meters, and *Pelometra*, known from only a single specimen dredged in 91 meters. Four genera, *Oxymetra, Pelometra, Liparometra*, and *Lamprometra*, are not known from a greater depth than 95 meters, though three, *Stephanometra, Mariametra*, and *Dichrometra*, extend down to more than 150 meters, the last having been brought up from 245 meters.

History.—The family Himerometridae, which I established in 1908, was on June 25, 1909, restricted by the removal of *Cenometra* and *Cyllometra* to the new family Colobometridae, which was not at the time defined. On September 14, 1909, it was further restricted by the establishment of the family Pontiometridae for the reception of the single genus *Pontiometra*, and at the same time was divided into three subfamilies, Himerometrinae, Stephanometrinae, and Mariametrinae.

In my paper on the systematic position of the genus *Marsupites* published on June 24, 1911, the families Stephanometridae, Pontiometridae, and Mariametridae were included in the families belonging to the suborder Oligophreata, the two last being here mentioned as families for the first time.

In a paper on the recent crinoids of Australia published on August 17, 1911, I formally divided the family Himerometridae as previously understood into three families, the Himerometridae, Stephanometridae, and Mariametridae (see p. 184).

In my memoir on the crinoids of the Indian Ocean published in 1912 I recognized the family Stephanometridae, with the genera *Oxymetra* and *Stephanometra*, the family Pontiometridae, with the genera *Pontiometra* and *Epimetra*, and the family Mariametridae, with the genera *Selenemetra, Mariametra*, and *Dichrometra*.

In a revision of the family Mariametridae published in 1913 I suppressed the family Pontiometridae, transferring the genus *Epimetra* to the Colobometridae and *Pontiometra* to the Mariametridae. As here constituted the family Mariametridae included the genera *Pontiometra, Oxymetra, Liparometra,* gen. nov., *Lamprometra,* gen. nov., *Dichrometra,* and *Mariametra.*

In the memoir on the unstalked crinoids of the *Siboga* expedition published in 1918 I recognized the family Stephanometridae, with the single genus *Stephanometra,* and the family Mariametridae, with the genera just given.

In the present work the family Mariametridae is considered as including, together with the genera assigned to it in 1913 (except *Pontiometra*), the genus *Stephanometra,* the family Stephanometridae being suppressed, and also the new genus *Pelometra.* The genus *Pontiometra* is herein placed in the family Colobometridae.

In his report upon the comatulids collected by the *Challenger* expedition Carpenter placed all the species of the family Mariametridae known to him in the *Palmata* group, which in addition included *Antedon manca, A. disciformis,* and *A. clemens,* the first two of which belong to the family Colobometridae, falling in the genus *Cyllometra,* while the third belongs to the family Himerometridae, falling in the genus *Heterometra.*

KEY TO THE GENERA OF THE FAMILY MARIAMETRIDAE

a^1. Cirri large and long, composed of more than 40 (usually of more than 50) segments (from the Philippines southward to New Britain and the Kei Islands, and westward to Ceylon; 0–82 meters)---------- **Oxymetra** (p. 396)

a^2. Cirri of moderate length or short, composed of less than 40 segments.

  b^1. One or more of the oral pinnules enlarged, greatly stiffened, sharp pointed, and spinelike; division series well separated, the component ossicles with rounded ventrolateral extensions (from Macclesfield Bank and Philippine Islands to Pelew, Caroline, and Marshall Islands, Samoa, Fiji, the Tonga Islands, New Caledonia, Torres Strait, and Lesser Sunda Islands, and westward to Madagascar; 0–245 meters)---------- **Stephanometra** (p. 407)

  b^2. Enlarged lower pinnules tapering distally to a fine and usually (but not always) flexible point, without spiniform tips; division series usually in lateral contact, the component ossicles never with ventrolateral extensions.

    c^1. Genital pinnules with a narrow expansion on lower edges of segments (Amboina; about 91 meters)---------- **Pelometra** (p. 459)

    c^2. No expansion of lower edge of segments of genital pinnules.

      d^1. P_2 and P_3 slender, similar, and of same length (southern Japan from Hirado Strait to Sagami Bay, Bonin Islands, and southward to Tonga Islands, Port Molle, Queensland Moluccas, and Lesser Sunda Islands; 0–69 meters)---------- **Liparometra** (p. 460)

      d^2. P_2 and P_3 unequal in length or stoutness, usually in both.

        e^1. P_2 longer and stouter than P_3 (from Hongkong and Philippines to Caroline, Marshall, and Hawaiian Islands, Fiji, Tonga Islands, New Caledonia, the Solomon Islands, northern Australia south to Cape Hillsborough, Queensland, and Abrolhos Islands and possibly Perth, Western Australia, and westward to east coast of Africa from Red Sea south to Dar-es-Salaam, Tanganyika Territory; 0–51 [?421] meters)

        Lamprometra (p. 472)

        e^2. P_3 longer and stouter than P_2.

          f^1. Lateral portions of dorsal surface of the division series smooth (from southern Japan, from Korean Straits to Sagami Bay, to Hongkong, Philippines, Pelew and Admiralty Islands, New Guinea, and Amboina, and westward to Madagascar and east coast of Africa from Lamu, Kenya, southward to Durnford Point, Zululand; 0–164 meters)---------- **Dichrometra** (p. 536)

f^2. Lateral portions of dorsal surface of division series with closely crowded small spines, tubercles, or granulations (southern Japan from Oki Islands in Sea of Japan to Tokyo Bay, and southward to Amboina, Kei Islands, Timor, Flores, and Sapeh Strait, and westward to Mergui Archipelago; 40–153 meters) **Mariametra** (p. 566)

Genus OXYMETRA A. H. Clark

Antedon (part) Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 176, and following authors.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Dichrometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, pp. 13, 76.

Oxymetra A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (characters; genotype *Antedon erinacea* Hartlaub, 1890), p. 176 (referred to the Stephanometrinae); Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 725 (absent from Australia); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 22 (includes *Selenemetra*); Crinoids of the Indian Ocean, 1912, p. 57 (in key), p. 131 (original reference; type); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 141 (includes *Selenemetra;* referred to the Mariametridae), p. 143 (synonymy; genotype; range, depth; included species), p. 142 (in key); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 97 (in key; range), p. 98 (key to the included species).

Selenemetra A. H. Clark, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 541 (diagnosis; genotype *Antedon finschii* Hartlaub, 1890; referred to the Mariametrinae); Memoirs of the Australian Mus., vol. 4, pt. 15, 1911, p. 725 (absent from Australia); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 22 (synonym of *Oxymetra*); Crinoids of the Indian Ocean, 1912, p. 9 (absent from Australia), p. 10 (absent from Japan; reason), p. 11 (represented in Ceylon region), p. 22 (distribution in detail), p. 57 (in key), p. 139 (original reference; type); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 141 (synonym of *Oxymetra*).

Diagnosis.—A genus of Mariametridae in which the cirri are long and stout with more than 40 (rarely less than 50) segments, of which the distal bear dorsal spines; several pairs of the proximal pinnules are moderately enlarged and moderately elongated, and more or less stiffened, at least in the basal half; and the arms are 40 or more in number.

Geographical range.—From the Philippine Islands southward to New Britain and the Kei Islands and westward to Ceylon.

Bathymetrical range.—From the shoreline down to 82 meters.

Remarks.—The genus *Oxymetra* as herein understood includes three closely related species that may eventually prove to be simply more or less distinct forms of the same species.

Although *Oxymetra erinacea* with its stiff, enlarged, and spinelike proximal pinnules seems at first sight to be very different from *O. finschii* with its more slender proximal pinnules of which more or less of the distal portion is flexible, this difference is really of little importance, for in many single species in genera of the Zygometridae, Himerometridae, Mariametridae, and Colobometridae the proximal pinnules vary greatly in length and stiffness. *Oxymetra tenuicirra* is simply a form of *O. erinacea* with elongated cirrus segments.

History.—The two first-known species of this genus, *finschii* and *erinacea,* were described by Dr. Clemens Hartlaub in the genus *Antedon* in 1890.

When the new genus *Himerometra* was established by me in 1907 both of these species were included in it. In 1908 I described a new species under the name of *Himerometra gracilipes* (=*finschii*).

In the revision of the family Himerometridae published on January 9, 1909, I referred *Himerometra gracilipes* to the new genus *Dichrometra.* I said that I had not been able satisfactorily to place *Antedon finschii* and *A. erinacea* because of a lack of material for comparison. I remarked that the first (*finschii*) appears to be most closely related to *Pontiometra andersoni*, and the diagnosis of the genus *Pontiometra* may have to be altered for its reception; the second (*erinacea*) appears to represent a distinct generic type for which the name *Oxymetra* would be appropriate.

In a paper published on April 17, 1909, I described a new species, *Dichrometra aranea*, in the family Himerometridae.

In a paper published on September 14, 1909, a new subfamily of the family Himerometridae, the Stephanometrinae, was established, which included the genera *Oxymetra* and *Stephanometra;* the genera *Mariametra* and *Dichrometra* were placed in another new subfamily, the Mariametrinae.

In 1911 I established the new genus *Selenemetra* in the subfamily Mariametrinae, with *Antedon finschii* as the genotype. At the same time I described a new species in this genus, *S. viridis.*

In a paper on the crinoids of the Hamburg Museum published in 1912, after a personal examination of Hartlaub's type specimen of *Antedon erinacea,* I said that this species has nothing to do with the species of *Stephanometra* but is closely related to the species that I had grouped in the genus *Selenemetra*, especially to *S. tenuicirra.* Pointing out that the generic name *Oxymetra* with *Antedon erinacea* as the genotype has precedence over *Selenemetra* with *Antedon finschii* as the genotype, I said that all the species heretofore assigned to *Selenemetra* must be transferred to *Oxymetra,* of which *Selenemetra* is a synonym.

In my memoir on the crinoids of the Indian Ocean, published 13 days later than the preceding paper, though written some time before it, I placed *Oxymetra*, with the single species *erinacea*, in the family Stephanometridae, and *Selenemetra*, with the species *finschii*, *aranea*, *gracilipes*, and *viridis*, in the family Mariametridae.

In my revision of the family Mariametridae published in 1913 the genus *Oxymetra* is given with *Selenemetra* as a synonym, and the species *aranea*, *erinacea*, *finschii*, *gracilipes*, *tenuicirra*, and *viridis* are listed as belonging to it.

In my report on the unstalked crinoids of the *Siboga* expedition I included a key to the species of *Oxymetra*. The species recognized were *tenuicirra*, *erinacea*, *finschii* (including *gracilipes*), and *aranea* (including *viridis*).

KEY TO THE SPECIES IN THE GENUS OXYMETRA

a^1. Cirrus segments long, the longest about twice as long as broad and the distal about as long as broad; 69–78 cirrus segments; 49 arms 150 mm. long (between Borneo and eastern Java; 82 meters)--**tenuicirra** (p. 401)

a^2. Cirrus segments shorter, the longest but little longer than broad and the distal twice as broad as long or even broader.

  b^1. First four pairs of pinnules very stiff and spinelike; 36–51 (usually more than 40) arms 90–115 mm. long; cirri with 48–63 (usually 50–60) segments (Philippines to Kei Islands, and westward to Sunda Strait; 0–50 meters)------------------------------**erinacea** (p. 398)

  b^2. Proximal pinnules, though somewhat stiffened, are not spinelike, but become flexible distally and end in a delicate and more or less flagellate tip; 41–80 cirrus segments; 40–44 arms 90–140 mm. long (Philippines to New Britain and westward to northeastern Ceylon; 0–77 meters)--**finschii** (p. 402)

OXYMETRA ERINACEA (Hartlaub)

PLATE 41, FIGURES 189, 190; PLATE 42, FIGURE 194

Antedon erinacea HARTLAUB, Nachr. Ges. Göttingen, May 1890, p. 177 (description; Cebu); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 38 (in key), p. 52 (detailed description and comparisons; Cebu), p. 58 (in first section of species of the *Palmata* group with spiny lower pinnules), pl. 3, fig. 29.—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (type of *Oxymetra*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity); Crinoids of the Indian Ocean, 1912, p. 37 (identity.)

Himerometra erinacea A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Oxymetra erinacea A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity), p. 21 (Cebu; detailed description of the type), p. 22 (comparison with *finschii* and *tenuicirra*); Crinoids of the Indian Ocean, 1912, p. 37 (identity); p. 132 (synonymy; Cebu); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 99 (in key; range).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 33.

Diagnostic features.—The longest cirrus segments are but little longer than broad, and the distal cirrus segments are twice as broad as long or even broader; the pinnules of the first four pairs are enlarged, moderately elongated, much stiffened, spinelike, and more or less erect; there are 36–51 (usually more than 40) arms 90–115 mm. long; and the cirri have 48–63 (usually 50–60) segments.

Description.—The centrodorsal is large and hemispherical and is almost entirely covered by cirrus sockets. The dorsal pole is very small, irregular in shape, and slightly concave.

The cirri are XXX–XXXV (about XXV according to Hartlaub), 50–60, about 40 mm. long. They are rather scattered, rather thin and slender, and are distally somewhat compressed laterally. The longer proximal segments are about as long as broad. After the middle of the cirri the segments gradually decrease in length so that those in the outer portion of the cirri are twice as broad as long. The shorter segments in the distal half of the cirri have the distal dorsal edge thickened and everted and very finely spinous, this eversion gradually becoming more and more triangular in end view, the spinosity concurrently becoming gradually restricted to the lateral part of the eversion, and on the terminal segments becoming a single smooth sharp spine. The opposing spine is well developed.

The radials are partially visible in the interradial angles of the calyx. The IBr_1 are laterally united. The IBr_2 (axillaries) are pentagonal. The postradial series divide four times, but the IVBr series arise only on the outer side of the IIIBr axillaries. In other words, the arms are arranged in 3, 2, 2, 3 order so that the normal number of arms is $(3+2+2+3)\times5=50$. The division series are 2 and are rather slender and elongated. They are somewhat compressed laterally with a strongly convex dorsal surface and perfectly straight sides. Small synarthrial tubercles are present. The division series are rather widely separated, and the outermost arms are rather rarely in contact. The two ossicles following each axillary, with the exception of the first brachials, are always only partially united.

The 51 arms in the type specimen are rather slender and relatively short and are 105–115 mm. in length. Their dorsal surface is entirely smooth. The first brachials are strongly rounded dorsally, somewhat thickened dorsoventrally, and as long as broad. The second brachials are slightly longer exteriorly than interiorly. The first syzygial pair (composed of brachials 3+4) is markedly longer than broad.

About eight or nine of the following brachials are oblong, and those succeeding are shorter and rather sharply wedge-shaped. Toward the ends of the arms the brachials become more bluntly wedge-shaped, and finally more squarish.

Syzygies occur between brachials 3+4, again somewhere between the forty-first and fifty-first brachials, and distally at intervals of usually nine or ten, but occasionally only four, muscular articulations.

The disk is surrounded by a thick circlet of spiny pinnules. The pinnules of the first four pairs are very stiff and sharply spiny. Those of the first and second pairs are about 14 mm. long and are composed of about 25 short segments. The pinnules of the third and fourth pairs decrease in length. P_5 on the outer arms is also stiffened and is about 5 mm. long. P_6 and P_7 are very small. The following pinnules gradually increase in length, distally reaching about 8 mm. The spiny pinnules are equally stout on all the arms, and the pinnules on the inner side of the arms are as long as those on the outer. The segments of the enlarged lower pinnules are all short, about as long as broad, and of uniform size. These pinnules are stiffened, though scarcely so much so as those of the species of *Stephanometra,* and the tip, though sharp, ends in the normal manner. The pinnules are more slender than the enlarged and spiny pinnules of *Stephanometra* and are evenly tapering.

The disk of the type specimen has been lost. Sacculi are thickly set on the pinnules.

The color in alcohol is uniform light brown.

Notes.—The preceding description is adapted from Hartlaub's original description, with supplementary information supplied by my examination of the type specimen at Hamburg in 1910.

The specimen from the Danish expedition to the Kei Islands station 20 has 35 arms 110 mm. long.

One of the specimens from the Danish expedition to the Kei Islands station 90 has 41 arms 95 mm. long. A single IVBr series is present, on the outer side of one of the inner IIIBr series—that is, next to the midradial line. The cirri are XXXVI, 54–63, from 40 to 50 mm. long. The longest cirrus segments are one-third again as long as broad, and the short distal segments are from half again to twice as long as broad. P_1 is much stiffened, 9 mm. long with 20 segments of which the first is very short, the fourth is nearly as long as broad, and the tenth and following are twice as long as broad. The distal side of the segments (toward the arm tip) is slightly concave. P_2 is cylindrical, 10 mm. long, with 19 segments; it is about as stout basally as P_1 but tapers more gradually and is less slender distally. P_3 is 6 mm. long with 13 segments, of which the last three or four are about three times as long as broad. P_4 is 5.5 mm. long, with 12 segments.

Another specimen has 49 arms 105 mm. long; the extra axillary is next to the midradial line. The cirri have 50–52 segments and are up to 40 mm. in length. P_1 is 11.5 mm. long, with 22 segments. P_2 is 12 mm. long, with 22 segments, more stiffened than P_1, tapering very slowly and therefore stouter in the distal half. P_3 is 9 mm. long, with 17 segments, and resembles P_2. P_4 is 6.5 mm. long, with 14 segments, and resembles P_3.

A third specimen has 44 arms 110 mm. long. The extra axillaries are usually next the midradial line. The cirri have 51–55 segments and are from 40 to 45 mm. long.

A fourth example has 44 arms 110 mm. long. The cirri have 48–57 segments and are 40 to 43 mm. long.

Another specimen has 36 arms 90 mm. long.

Other specimens have 38 (1), 40 (3), 41 (1), 42 (2), 43 (3), 44 (1), 45 (4), and 46 (3) arms, which are usually from 100 to 110 mm. long.

Abnormal specimen.—In a specimen from the Danish expedition to the Kei Islands station 90 with 46 arms 90 mm. long one of the arms, the outermost arm on one of the postradial series, has the tenth brachial bearing both the continuation of the arm and on the outer side another arm about two-thirds as large, which is directed obliquely distally at an angle of 45°.

Localities.—Cebu, Philippines; Captain Ringe [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1912, 1918] (1, H. M.).

Danish expedition to the Kei Islands; Dr. Th. Mortensen; station 20; about 50 meters; sand and shells; April 14, 1922 (1).

Danish expedition to the Kei Islands; Dr. Th. Mortensen; station 90; Sebesi Strait, between Java and Sumatra; 36 meters; hard bottom; August 1, 1922 (24).

Geographical range.—From the Philippines southward to the Kei Islands and westward to the Sunda Strait, between Java and Sumatra.

Bathymetrical range.—From the shoreline down to about 50 meters.

History.—This species was described from a specimen from Cebu collected by Captain Ringe under the name of *Antedon erinacea* by Dr. Clemens Hartlaub in 1890 and was described and figured in the following year.

Hartlaub said that *Antedon erinacea* is an undoubted new species, immediately distinguished from all related species by the large number of spinelike pinnules that surround the disk and also by the relatively short and numerous segments of these pinnules. He said that the single species that in respect to the shortness and number of segments in the proximal pinnules resembles *erinacea* is *Antedon* (*Stephanometra*) *indica*, but that any confusion with this species is prevented because this form, in contrast to *erinacea*, possesses only a small number of elongated and styliform pinnules. He noted that *erinacea* differs from all similar species in the following points: It has relatively very long cirri, which are composed of 50–60 segments; it possesses IVBr series, and therefore a large number of arms; and lastly—a feature that is very characteristic—the second syzygy is separated by an unusually long distance from the first.

In my first revision of the old genus *Antedon* published in 1907 this species was referred to the new genus *Himerometra*. In the revision of the family Himerometridae published in 1909 I did not place *Antedon erinacea* definitely in any genus. I said that it appears to represent a distinct generic type for which the name *Oxymetra* would be appropriate.

In a paper on the crinoids of the Hamburg Museum published in 1912 I gave notes on the type specimen of *Antedon erinacea*, which I had examined in 1910, and said that this species is most nearly related to that which I had recently described under the name *Selenemetra* (=*Oxymetra*) *tenuicirra*, which has similarly stiffened and enlarged proximal pinnules; but in *tenuicirra* the pinnules are stouter proximally and more delicate distally so that they taper less regularly, and they are considerably shorter, while the cirri are very much longer with more numerous segments of which the distal are much longer. I said that from the published description and figure I had assumed that this form was allied to the species of *Stephanometra* with which it was associated by Hartlaub and, as it differed materially from all the forms which I had grouped in that genus, I had suggested the generic name *Oxymetra* for it. Examination of the specimen, however, showed that it has nothing to do with the species of *Stephanometra* but instead is closely related to the species which I had grouped in the genus *Selenemetra*, especially to *S. tenuicirra*.

In my memoir on the crinoids of the Indian Ocean published in 1912 *Oxymetra erinacea* was placed in the family Stephanometridae, *Selenemetra* and the species included in it (*finschii*, *aranea*, *gracilipes*, and *viridis*) being assigned to the family Mariametridae.

In my report on the unstalked crinoids of the *Siboga* expedition, *erinacea* was included in the key to the species of the genus *Oxymetra* but was not further considered, as it was not secured by the *Siboga*.

OXYMETRA TENUICIRRA (A. H. Clark).

PLATE 43, FIGURES 195, 196

Selenemetra tenuicirra A. H. CLARK, Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 32 (description; *Siboga* station 320); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 22 (nearest to *Oxymetra erinacea;* comparison).

Oxymetra tenuicirra A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. VIII (discovery by the *Siboga* and its significance), p. 98 (in key; range), p. 99 (detailed description; station 320), p. 276 (listed), pl. 19, figs. 37, 38.—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 33.

Diagnostic features.—Resembling *O. erinacea* but with the cirrus segments longer, the longest about twice as long as broad and the distal about as long as broad; there are 49 arms 150 mm. long and the cirri have 69–78 segments.

Description.—The cirri are XXXV, 69–78, from 55 to 70 mm. long, much slenderer than those of *O. finschii*, with much longer distal segments, which are nearly or quite as long as broad, and also longer proximal segments, the longest of which are about twice as long as broad.

Each IIBr series bears two IIIBr series of which the inner bears an internal IVBr series so that there are normally 10 arms to each ray arranged in 2, 3, 3, 2 order.

The 49 arms are 150 mm. long.

P_1 is 11 mm. long, with 20 or 21 segments, which become about as long as broad on the fifth or sixth, and twice as long as broad distally. P_2 is 12 mm. long, with 22 segments, resembling P_1. P_3 is 10 mm. long, with 18 segments. P_4 is 7.5 mm. long, with 13 segments and with the distal taper more marked than in P_3. P_5 is 7 mm. long, with 13 segments, slightly slenderer than P_4, especially in the distal portion. The distal pinnules are 8 mm. long, with 17 segments.

Remarks.—This species is very closely related to *Oxymetra erinacea*, from which it differs chiefly in having slenderer cirri with much longer distal segments, which are nearly or quite as long as broad instead of twice as broad as long or even broader as in *O. erinacea*, and also longer proximal segments, the longest of which are about twice as long as broad instead of only slightly, if at all, longer than broad.

Locality.—*Siboga* station 320; between Borneo and eastern Java (lat. 6°05′00″ S., long. 114°07′00″ E.); 82 meters; fine gray mud; February 23, 1900 [A. H. Clark, 1912, 1918] (1, Amsterdam Mus.).

History.—This species was first described by the present author under the name of *Selenemetra tenuicirra* in 1912 from a single specimen dredged by the *Siboga* at station 320. In the original description it was said to be closely related to *Oxymetra finschii.* In another paper published in the same year it was compared with *O. erinacea* to which it was said to be most closely related. It was redescribed in detail and figured in 1918.

OXYMETRA FINSCHII (Hartlaub)

Plate 37, Figure 168; Plate 42, Figures 191–193; Plate 44, Figures 197–202; Plate 45, Figures 203, 204

[See also vol. 1, pt. 2, fig. 195 (lateral view), p. 122; figs. 476, 477 (pinnule tip), p. 269.]

Antedon finschii Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 176 (description; New Britain); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 37 (in key), p. 47 (detailed description and comparisons), p. 113 (in Göttingen Mus.); pl. 3, fig. 32.—Koehler, Mém. Soc. Zool. France, vol. 8, 1895, p. 419 (Sunda Islands, Biliton; notes).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (related to *Pontiometra andersoni*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 22 (referred to *Oxymetra*); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 383 (identity); Crinoids of the Indian Ocean, 1912, p. 37 (same).

Himerometra finschii A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra gracilipes A. H. Clark, Smithsonian Misc. Coll., vol. 52, 1908, p. 219 (description; *Albatross* station 5163); Proc. U. S. Nat. Mus., vol. 39, 1911, p. 541, footnote (referred to *Selenemetra*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 99, footnote 1 (=*Oxymetra finschii*).

Dichrometra aranea A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 76 (description; lat. 8°51′30″ N., long. 81°11′52″ E.; 28 fathoms).

[*Dichrometra*] *finschii* A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 76 (compared with *D. aranea*).

Dichrometra gracilipes A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed).

Selenemetra viridis A. H. Clark, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 541 (description; *Albatross* Sta. 5413); Crinoids of the Indian Ocean, 1912, p. 139 (synonymy; locality); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 99, footnote 2 (synonym of *Oxymetra aranea*).

Selenemetra gracilipes A. H. Clark, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 541 (calyx and arm bases compared with those of *S. viridis*); Crinoids of the Indian Ocean, 1912, p. 139 (synonymy; locality).

Selenemetra finschii A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 253 (compared with *Dichrometra articulata*); Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 32 (compared with *S. tenuicirra*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 22 (comparison with *Oxymetra erinacea;* congeneric with that species; *Oxymetra* has priority over *Selenemetra* so that this species becomes *Oxymetra finschii*); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 382 (cotype from New Britain in U.S.N.M.), p. 383 (identity), p. 397 (New Britain); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 139 (synonymy; New Britain).—Hartmeyer, Mitt. zool. Mus. Berlin, vol. 8, Heft 2, 1916, p. 235 (Neu Pommern, Nos. 2602, 2603 [1 specimen]).

Selenemetra aranea A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 139 (synonymy; detailed description; locality), fig. 15, p. 140.

Oxymetra finschii A. H. Clark, Unstalked crinoids of the *Siboga* Exped., 1918, p. 99 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.

Oxymetra aranea A. H. Clark, Unstalked crinoids of the *Siboga* Exped., 1918, p. 99 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.

Oxymetra finshii Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 33.

Diagnostic features.—The longest cirrus segments are but little longer than broad, and the distal cirrus segments are twice as broad as long or even broader; the proximal pinnules are less enlarged than are those of *O. erinacea* and, though more or less stiffened basally and moderately elongated, they are flexible distally; there are 40–44 arms 90–140 mm. long; and the cirri have 41–80 segments.

Description.—The centrodorsal is hemispherical and is more or less completely covered with cirrus sockets.

The cirri are composed of 60–80 segments and may reach a length of 60 mm. In the proximal portion of the cirri the segments, except for a few of the basal ones, are usually slightly longer than broad; the remaining segments become gradually slightly shorter. At a variable distance from the base of the cirri the distal dorsal edge of the segments begins to project and later develops a sharp spine that retains its distal position on the segment almost to the end of the cirri but here passes back more toward the middle.

The radials are more or less completely, and sometimes wholly, visible. Their dorsal surface is approximately parallel with the dorsoventral axis of the animal. The IBr_1 are incompletely united laterally; they are as long as the free sides of the rather large and pentagonal IBr_2 (axillaries). The postradial series as a rule divide three times. Individual IVBr series may be present. All the division series are 2. The IVBr series, if present, occur always on the inner side of the inner IIIBr axillaries. The articulations between the elements of the division series are tubercular. The post-radial series from the IBr_1 to the IIIBr axillaries often have their outer side more or less strongly produced into a shelflike border with sharp edges and a flattened outer side, but the thickening of the ventrolateral edges of the individual ossicles collectively forming this border may be discontinuous without any flattening. In other cases the production of the outer sides of the postradial series may be lacking altogether, their outer sides being entirely smooth. When their lateral edges are strongly produced the post-radial series are almost in lateral contact, otherwise they are well separated.

There are 40, or a few more, arms 140 mm. long. The arms are long, smooth, and rather slender, with the dorsal surface strongly rounded. The lowest brachials may have flattened sides. The first brachials are entirely, or only partially, united interiorly. They are somewhat shorter than the second brachials, which are approximately square. The first syzygial pair (composed of brachials 3+4) is markedly longer than broad. This is succeeded by six to nine more or less discoidal brachials, which bear a small lateral produced point, alternating in position on succeeding brachials, on their proximal borders. On their distal borders they sometimes bear a similar small sharp process. These are followed by a series of rather short triangular brachials, which before the middle of the arm pass over into bluntly wedge-shaped brachials. Toward the end of the arms the brachials become more square. The triangular and bluntly wedge-shaped brachials have on their distal edge a sharp production laterally placed and alternating in position on succeeding brachials.

The first syzygy is between brachials 3+4, the second is from the thirty-ninth to the forty-sixth brachial, and the distal intersyzygial interval is from 4 to 21, often from 5 to 10, muscular articulations.

The lower pinnules are equally long on all the arms, and on individual arms are as long on the inner as on the outer side. They are slender and gradually tapering. The pinnules of the first pair are mostly about as long as those of the second. These last are always somewhat thicker; they measure about 11 mm. in length and are composed of about 20 fairly equal segments, of which most are as a rule somewhat longer than broad. The following three or four pairs decrease in length and in the number of their component segments. The smallest pinnule is about 5 mm. long. The pinnules succeeding slowly increase in size, finally reaching a length of 10 mm.

The disk is about 16 mm. in diameter and is strongly incised. The sacculi are closely crowded on the pinnules.

The color is uniform gray-brown, sometimes with a touch of green, the cirri lighter, and the disk dark blackish gray.

Notes.—The preceding description is adapted from Hartlaub's original description of the species. I have examined both of Hartlaub's specimens, one of which is now in the United States National Museum.

The specimen from *Albatross* station 5413 was described as a new species under the name of *Selenemetra viridis* as follows: The cirri are XXXIII, 47–57, from 30 to 35 mm. long, and rather slender. Sharp dorsal spines are developed from the tenth or twelfth segment—a more or less marked transition segment—onward. The calyx and arm bases resemble those of *S. gracilipes* (=*Oxymetra finschii*), but the division series and first ten brachials are sharply flattened laterally. The 40 arms are 90 mm. long. P_1 is slender, 10 mm. long, with 19 segments, which become twice as long as broad distally. P_2 and P_3 are similar, 12 mm. long, with 21 segments, slightly stiffer than P_1 and proportionately stouter. P_4 is 9 mm. long, with 18 segments; it is as slender as P_1 but slightly stiffer. P_5 is 7 mm. long and resembles P_4. P_6 is 5.5 mm. long and resembles P_5 but is less stiffened. P_7 and the following pinnules are 5 mm. long; their component segments are proportionately slightly shorter than are those of the pinnules preceding. The distal pinnules are very slender and reach 7 mm. in length. The color is greenish yellow.

The specimen from *Albatross* station 5163 was described as a new species under the name of *Himerometra gracilipes* in the following terms: The centrodorsal is a thick disk with a small flat polar area. The cirri are arranged in two and a partial third crowded, irregular, and more or less alternating rows. The cirri are XIX, 41–52 (usually about 50), 35 to 40 mm. in length. The first segment is about twice as broad as long, and those following gradually increase in length to the fifth or sixth which is about as long as broad. The succeeding segments remain the same, or become slightly longer than broad, to about the twenty-sixth, then gradually become shorter, about half again as broad as long. After the twentieth to the twenty-second segment dorsal spines gradually begin to develop; these, however, never become very large. The opposing spine is terminal, erect, and about half as long as the width of the penultimate segment. The terminal claw is longer than the penultimate segment and is slender and moderately curved.

The radials are very prominent and are about twice as broad as long; their dorsal surface is parallel with the dorsoventral axis of the animal. Each radial bears a low, rounded posterolateral tubercle on each side. The IBr_1 are trapezoidal, about three times as broad as long proximally and twice as broad as long distally; they are basally united but diverge very rapidly distally. The IBr_2 (axillaries) are pentagonal, about half again as broad as long. The IIBr, IIIBr, and IVBr series are 2 and are widely separated; the IVBr series are developed only on the outer side of the IIBr series. The 44 arms are 90 mm. long. The first ten brachials are oblong, not quite twice as broad as long, those succeeding are wedge-shaped, almost triangular, about twice as broad as long, becoming proportionately longer in the distal part of the arms. Syzygies occur between brachials 3+4, again from between brachials 44+45 to between brachials 56+57 (usually nearer the latter), and distally at intervals of 6 to 11 (usually 7 to 9) muscular articulations.

P_1 is 10 mm. long, slender but somewhat stiffened, tapering evenly from the base to the delicate tip, composed of 22 segments, of which the first is about twice as broad as long, the fourth is about as long as broad, and those following gradually increase in length so that the seventh and following are about half again as long as broad. P_2 is usually slightly longer than P_1 and is composed of 17 segments, of which those in the distal part are more elongated than the corresponding segments in P_1. P_3 is 5.5 mm. long, with 12 segments, and is of the same character as the two preceding pinnules. The following pinnules are small, short, and delicate, 4 mm. long, with 12 segments, of which the first three are about as long as broad and the remainder are longer than broad, becoming about twice as long as broad distally. The distal pinnules are 7 mm. long, with 20 segments of which the first is short, the second is about as long as broad, the third is about half again as long as broad, and the remainder are about twice as long as broad or rather longer. The color in alcohol is brownish gray.

In the specimen recorded by Koehler from Billiton the cirri reached a length of 60 mm. The arms were exactly 40 in number, 100 to 120 mm. long; each postradial series divided regularly three times. Professor Koehler said that this specimen conformed in all respects with Hartlaub's description.

The specimen from *Investigator* station 175 was described as a new species under the name of *Dichrometra aranea.* This new species was said to be nearest *O. finschii,* differing from that form in having fewer cirrus segments (53–66) and in having P_3 nearly or quite as long as P_2, while the segments in the distal portion of the proximal pinnules are much elongated instead of subequal, slightly longer than broad, as in *O. finschii.* The lower pinnules are comparatively slender and are only slightly stiffened. P_2 is about as stout as P_1 and 2 mm. longer.

Localities.—Albatross station 5413; between Cebu and Bohol, Philippines; Lauis Point light bearing N. 68° W., 10 miles distant (lat. 10°10′35″ N., long. 124°03′15″ E.); 77 meters; March 24, 1909 [A. H. Clark, 1911, 1912, 1918] (1, U. S. N. M., 27491).

Albatross station 5163; Tawi Tawi group, Sulu (Jolo) archipelago; Observation Island bearing N. 79° W., 6.7 miles distant (lat. 4°59′10″ N., long. 119° 51′00″ E.); 51 meters; coral sand; February 24, 1908 [A. H. Clark, 1908, 1909, 1911, 1912, 1918] (1, U. S. N. M., 25455).

New Britain; Dr. Otto Finsch [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1918; Hartmeyer, 1916] (2, U. S. N. M., 35268; Berl. M., 2602, 2603 [1 specimen]).

Biliton, between southeastern Java and Borneo; M. Korotnev, 1885 [Koehler, 1895].

Investigator station 175; off northeastern Ceylon (lat. 8°51′30″ N., long 81°11′52″ E.); 51 meters; April 20, 1894 [A. H. Clark, 1909, 1912, 1918] (1, U. S. N. M., 35241).

Geographical range.—From the Philippines southward to New Britain and westward to northeastern Ceylon.

Bathymetrical range.—From the shoreline down to 77 meters.

History.—This species was originally described in 1890 by Dr. Clemens Hartlaub as *Antedon finschii* from four specimens in the Berlin Museum, which had been collected in New Britain (Neu-Pommern) by Dr. Otto Finsch. It was redescribed in greater detail and figured in the following year. One of the original specimens was subsequently transferred to Göttingen and another to the United States National Museum.

Hartlaub said that this fine new species is easily distinguished from all the other members of the *Palmata* group. In the first place the cirri, which are composed of 60–80 segments and may reach a length of 60 mm., are unusually long for a member of this group, and in the second place the strong flattened productions of the outer sides of the postradial series are highly characteristic. He noted that the development of the shelflike production of the sides of the postradial series is very variable, and on some rays it is wholly lacking. According to Hartlaub this species in these features very decidedly approaches the *Spinifera* group, but it cannot be included in that group because its pinnules have no ambulacral skeleton.

In 1895 Prof. René Koehler recorded and gave notes on a specimen that had been collected by M. Korotnev in 1885 at Biliton.

In my first revision of the old genus *Antedon* published in 1907, *Antedon finschii* was referred to the new genus *Himerometra.*

In 1908 I described a new species, *Himerometra gracilipes,* from *Albatross* station 5163 in the Philippines.

In a revision of the family Himerometridae published in 1909, I referred *gracilipes* to the new genus *Dichrometra.* I said that I had not been able to place *Antedon finschii* satisfactorily because of lack of material for comparison, but that it appears to be most closely related to *Pontiometra andersoni,* and the diagnosis of the genus *Pontiometra* may have to be altered for its reception. Later in 1909 I described *Dichrometra aranea* from a specimen from *Investigator* station 175.

In 1911 I established the new genus *Selenemetra* with *Antedon finschii* as the genotype, at the same time describing *Selenemetra viridis* from *Albatross* station 5413. In another paper published in the same year I compared *Selenemetra finschii* with *Dichrometra articulata.*

In a paper on the crinoids of the Hamburg Museum published on November 7, 1912, I said that from the published description and figure of *Antedon erinacea* I had assumed that this form is allied to the species of *Stephanometra* with which it was associated by Hartlaub and, as it differed materially from all the forms I had grouped in that genus, I had suggested the generic name *Oxymetra* for it. Examination of the type specimen, however, showed that it had nothing to do with the species of *Stephanometra* but instead is closely related to the species I had grouped in the genus *Selenemetra,* especially to *S. tenuicirra.* The generic name *Oxymetra* with *Antedon erinacea* Hartlaub as the genotype has precedence over the generic name *Selenemetra* with *Antedon finschii* Hartlaub as the genotype, so that all the species heretofore assigned to the genus *Selenemetra* must be transferred to the genus *Oxymetra*, and the name *Selenemetra* must be relegated to the synonymy of *Oxymetra*.

In a paper on the crinoids of the Berlin Museum published on November 20, 1912, I noted that I had examined the two cotypes of *Selenemetra finschii* in that museum.

In my memoir on the crinoids of the Indian Ocean published in 1912, I listed *Selenemetra finschii*, *S. aranea*, *S. gracilipes*, and *S. viridis* as valid species and redescribed *S. aranea*. In the original description of *S. tenuicirra*, which was published in 1912, that form was compared with *S. finschii*.

Dr. Robert Hartmeyer in 1916 published a note correcting the catalog numbers of the type specimen of *Selenemetra finschii* in the Berlin Museum.

In my memoir on the unstalked crinoids of the *Siboga* expedition published in 1918 a key to the species of *Oxymetra* was given in which *Oxymetra finschii* and *O. aranea* were both admitted as valid species; *O. finschii* was said to be characterized by having the first four or five pairs of pinnules stiffened and elongated, P_1 about as long as P_2, which is markedly longer than P_3, and 60–80 cirrus segments of which those in the outer half of the cirri bear small dorsal spines, and *O. aranea* was said to have the first six or seven pairs of pinnules stiffened and elongated, P_1 markedly shorter than P_2 and P_3, which are of the same length and character, and 47–66 cirrus segments of which the outer three-fourths bear prominent dorsal spines.

Genus STEPHANOMETRA A. H. Clark

Antedon (part) Lütken, Mus. Godeffroy Cat., vol. 5, 1874, p. 190 and following authors.

Comatula (part) Smith, Ann. Mag. Nat. Hist., ser. 4, vol. 17, 1879, p. 406.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Dichrometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13.

Stephanometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 9 (diagnosis; genotype *Antedon monacantha* Hartlaub, 1890); Amer. Nat., vol. 43, 1909, p. 254 (represented in Red Sea); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to the Stephanometrinae); Vid. Medd. Naturh. Foren. København, 1909, p. 170 (confirmation of the original generic diagnosis); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 10 (represented in West Indies by *Analcidometra*); Notes Leyden Mus., vol. 33, 1911, p. 185 (lateral processes on elements of division series characteristic of this genus absent in *Dichrometra flagellata*); Mem. Australian Mus., vol. 4, 1911, p. 732 (in key), p. 735 (1 species in Australia), p. 769 (original reference; characters; range; represented in Caribbean Sea by *Analcidometra*); Rec. Indian Mus., vol. 7, 1912, p. 269 (ventrolateral processes on ossicles of IBr series and early brachials compared with similar structures in *Oligometra intermedia*); Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 35 (lateral processes on division series and lower brachials compared with those of *Dichrometra tenuicirra*); Notes Leyden Mus., vol. 34, 1912, p. 145 (union of pinnule segments compared with the same in *Nanometra clymene*); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 401 (proximal pinnules compared with those of *Tropiometra audouini*); Crinoids of the Indian Ocean, 1912, p. 11 (Ceylon the western limit of the large and highly multibrachiate species); p. 12 (represented in southeast African region), p. 13 (corresponds to *Analcidometra*), p. 57 (in key), p. 132 (original reference; type); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 93 (key to included species).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 59, footnote (swimming movements), pp. 64, 66 (absence of muscular fossae on radial articular faces), p. 89 (articulation in IBr series), pp. 99, 100 (pinnule articulations), p. 235.

Lamprometra (part) H. L. Clark, Carnegie Inst. Washington Publ. 212, 1915, p. 104.

Diagnosis.—A genus of Mariametridae in which one or more of the oral pinnules are enlarged, greatly stiffened, sharp-pointed, and spinelike; the division series are well separated, and the component ossicles bear rounded ventrolateral extensions;

the cirri are short or of moderate length, with less than 40 segments; and the dorsal surface of the division series is smooth, without ornamentation.

Geographical range.—From the Macclesfield Bank and the Philippine Islands to the Pelew, Caroline, and Marshall Islands, Samoa, Fiji, the Tonga Islands, New Caledonia, Torres Strait, and the Lesser Sunda Islands westward to the Red Sea and Madagascar.

Bathymetrical range.—From the low-tide mark down to 245 meters. The species of *Stephanometra* are especially characteristic of the zone from the low-tide mark down to about 50 meters. Of the seven species, all have been taken in shore collecting, five are not known with certainty from a depth greater than 51 meters, one is recorded from 62 (possibly 73) meters, and one is recorded from 245 meters; there is some doubt about the correctness of the last record.

Remarks.—The genus *Stephanometra* includes seven species, which are rather sharply divisible into two groups.

In the species belonging to the first group the outer cirrus segments bear long, prominent, and sharp dorsal spines. These two species, *S. echinus* and *S. tenuipinna*, are alike in all features except such as might well be attributed to the relative maturity of the individuals assigned to one or the other. Although it is by no means certain that *S. tenuipinna* is simply the young of *S. echinus*, this will very likely turn out to be the case.

In the five species belonging to the second group the distal cirrus segments are wholly without dorsal spines, being at the most only slightly carinate dorsally. In this group the species are differentiated by the characters presented by the proximal pinnules. In all of them P_2 is enlarged, much stiffened, and spinelike. In one species, *S. spinipinna*, P_1 is stiffened and spinelike, though considerably slenderer and shorter than P_2, being intermediate in character between the stout, much stiffened, and spinelike P_1 found in *S. echinus* and *S. tenuipinna* and the slender and flexible P_1 found in *S. oxyacantha*, *S. spicata*, *S. protectus*, and *S. indica*. When the characteristic P_1 of *S. spinipinna* is typically developed the species is an easy one to recognize, but in this species P_1 is rather variable, and there is a suggestion of possible intergradation between *S. spinipinna* on the one hand and *S. spicata* and *S. oxyacantha* on the other. The four species in which P_1 is slender, delicate, and flexible are *S. oxyacantha*, *S. spicata*, *S. protectus*, and *S. indica*. In *S. oxyacantha* the second-fifth or second-fourth pinnules are stiffened and spinelike, in *S. spicata* the second and third, and in *S. protectus* and *S. indica* only the second. But there is really no hard and fast line of division between these forms. Pinnules of an intermediate type more or less enlarged and much stiffened for a greater or lesser distance from their base, but with the distal portion delicate and flexible, sometimes occur. As a result of the occurrence of such pinnules some individuals are intermediate between *S. oxyacantha* and *S. spicata*, while others are intermediate between *S. spicata* and *S. protectus*. Although *S. protectus* and *S. indica* when typically developed appear very different, some individuals from Ceylon have P_2 of a type intermediate between that characteristic of *S. protectus* and that characteristic of *S. indica*.

The species of the first group are somewhat limited in their distribution, occurring from the Philippines to New Britain, the Paternoster Islands, and Ceylon. The species of the second group range far to the eastward into Polynesia, southward to northern Australia, and westward to east Africa.

The species of *Stephanometra* are all inhabitants of shallow water and are most numerous in a narrow band just below the low tide mark. All the species are of medium or rather large size.

History.—The genus *Stephanometra* was established by me in 1909, with the genotype *Antedon monacantha* Hartlaub, 1890. The included forms had previously been placed in the genus *Himerometra* established in 1907. There has been no change in the status of the genus since its first description.

KEY TO THE SPECIES AND SUBSPECIES OF THE GENUS STEPHANOMETRA

a^1. Outer cirrus segments with long and prominent dorsal spines.
  b^1. 33–40 (usually 30–35) arms 110–170 mm. long; cirri with 25–37 segments (Philippines southward to Paternoster Islands and westward to "India" [possibly Ceylon]; 0–38 meters)---------- **echinus** (p. 409)
  b^2. 16–24 arms 60–70 mm. long; cirri with 20 segments (Philippines to New Britain, and westward to Ceylon; 0–48 meters)---------- **tenuipinna** (p. 413)
a^2. Outer cirrus segments without dorsal spines, being merely slightly carinate dorsally.
  b^1. P_1 stiffened and spinelike, resembling P_2 but somewhat smaller; 12–32 arms 35–150 mm. long; cirri with 15–23 segments (Borneo southward to the Moluccas and Kei Islands; 0–245 meters)---------- **spinipinna** (p. 415)
  b^2. P_1 flexible, flagellate, delicate, and slender, much smaller and weaker than the enlarged and stiffened P_2.
    c^1. P_2 the only pinnule enlarged and stiffened.
      d^1. P_2 much enlarged and stiffened, usually more or less straight, distally ending somewhat abruptly in a strong stout point, composed of 11–15 (usually 12) segments, of which the fourth and fifth are typically abruptly longer than the others (Macclesfield Bank and Philippines to Caroline and Marshall Islands, Samoa, Fiji, Tonga Islands, New Caledonia, and Torres Strait, and westward to Ceylon and Maldive Islands; 0–51 meters)---------- **indica protectus** (p. 443)
      d^2. P_2 somewhat less enlarged and stiffened, usually more or less strongly recurved, distally becoming very slender and delicate, though not flagellate, composed of 15–20 segments of which the fourth and fifth are not noticeably different from the rest (Madagascar, Seychelles, and Red Sea to Ceylon; Torres Strait; 0–62 [?73] meters)- **indica indica** (p. 436)
    c^2. P_3 and sometimes one or more of following pinnules enlarged and stiffened like P_2, though usually shorter.
      d^1. P_2 and P_3 the only pinnules enlarged, stiffened, and spinelike, P_4 being short and flexible like the succeeding pinnules (Macclesfield Bank and Philippines to Pelew and Caroline Islands, New Guinea, the Admiralty and Solomon Islands, Fiji, New Caledonia, and Torres Strait, and westward to Red Sea; 0–38 [?64] meters)---------- **spicata** (p. 424)
      d^2. P_4, or P_4 and P_5, stiffened and spinelike, resembling P_2 and P_3 though smaller (Philippines to Solomon Islands and Moluccas, and westward to Java; 0–16 [?23] meters)
oxyacantha (p. 418)

STEPHANOMETRA ECHINUS (A. H. Clark)

PLATE 45, FIGURES 205–207; PLATE 46, FIGURES 210, 211; PLATE 47, FIGURES 212–216

[See also vol. 1, pt. 2, fig. 125 (arm base), p. 79; fig. 273 (arm and pinnules), p. 207; figs. 467, 468 (pinnule tip), p. 266.]

Himerometra echinus A. H. CLARK, Smithsonian Misc. Coll., vol. 52, 1908, p. 218 (description; *Albatross* station 5147).

Stephanometra coronata A. H. Clark, Proc. U. S. Nat. Mus., vol. 36, 1909, p. 639 (description; "India"); vol. 39, 1911, p. 541 (Port Busin, Barias Island; "India"); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 19 (synonym of *echinus*); Crinoids of the Indian Ocean, 1912, p. 133 (synonymy; detailed description; localities), fig. 13, *a*, *b*, p. 133; Unstalked crinoids of the *Siboga* Exped., 1918, p. 93, footnote [1] (synonym of *echinus*).

Stephanometra echinus A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (listed); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 19 (includes *S. coronata;* no locality; fragments); Crinoids of the Indian Ocean, 1912, p. 132 (synonymy; locality); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 93 (in key; range), p. 94 (synonymy; notes; stations 40, 99), pp. 271, 272 (listed); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 15, fig. 52 (arm).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh. vol. 7, No. 1, 1936, p. 4 (French Indochina), p. 5 (range), p. 11 (Pulo Condor; notes), figs. 2, 2a, p. 9.

Diagnostic features.—The outer cirrus segments have long, sharp, and prominent dorsal spines; there are 30–40 (usually 30–35) arms 110–170 mm. long; and the cirri have 25–37 segments.

Description.—The centrodorsal is discoidal, with the moderately large bare polar area slightly concave; the cirri are arranged in two closely crowded more or less alternating rows.

The cirri are XXIV, 26–30, 25 mm. long. The first four segments are about twice as broad as long, the sixth is about as long as broad, and the seventh-tenth or -eleventh are about one-third again as long as broad; the segments succeeding are again about as long as broad, and those following gradually become shorter so that the terminal 12 or 14 are broader than long. The tenth and following segments bear large dorsal spines. The opposing spine is terminally situated, erect, and reaches about one-half the width of the penultimate segment in height. The terminal claw is rather longer than the penultimate segment and is slender and moderately curved.

The radials project slightly beyond the rim of the centrodorsal. The IBr_1 are proximally about four and distally about three times as broad as long; they are united in their basal third, but their sides diverge very rapidly from the point of union so that the free lateral borders of two adjacent IBr_1 form together an even and moderately curved line. The IBr_2 (axillaries) are broadly pentagonal, nearly twice as broad as long, with large and broad ventrolateral projections. The IIBr, IIIBr, and IVBr series are 2, bearing on the outer side, in common with the first brachials, large and broad ventrolateral processes.

The 40 arms are 110 mm. long. One of the internal IIIBr series is missing, but its loss is compensated by the development of an external IVBr series on the same IIBr series. The first 9 or 10 brachials are oblong or very slightly wedge-shaped, about twice as broad as long, those following becoming short-triangular, rather more than twice as broad as long, and short-wedge-shaped in the distal portion of the arms.

Syzygies occur between brachials 3+4, again from between brachials 22+23 to between brachials 32+33 (most frequently in the vicinity of the twenty-third brachial), and distally at intervals of from 9 to 24 (usually 9–13) muscular articulations.

P_1 is large, stiff, and spinelike, resembling P_2, with 15 segments and reaching 15 mm. in length. The first two segments are nearly twice as broad as long, the third is about as long as broad, and those succeeding increase in length so that the seventh and following are from one and one-half times to nearly twice as long as broad. P_2 is 16 mm. long with 12 or 13 segments, of which the distal are rather longer than the distal segments of P_1. P_3 is 15 mm. long, resembling P_2. P_4 is 12 mm. long, with 11 segments, resembling P_3. The pinnules following decrease in length and also slightly in stoutness, P_7 being 7 mm. long, with 10 segments, then gradually lose their peculiar stiffness, and later gradually increase in length. The distal pinnules are 10 mm. long, with about 20 segments, of which the first two are not so long as broad, the third is about as long as broad, and the remainder are about one-third again as long as broad, becoming half again as long as broad distally.

The color in alcohol is dull yellowish, with the division series and arms thickly covered with small red spots and blotches; the ventral perisome is brown.

Notes.—The specimen from Barias Island is a fine example of the species closely resembling the type specimen of *Stephanometra coronata* in the Indian Museum at Calcutta, with which it was directly compared. It has 34 arms about 150 mm. long; four of the postradial series bear seven arms each, and one bears six. As in the type specimen of *coronata*, the division series omitted are always internal. The cirri are XVIII, 27–29, from 26 to 28 mm. long. The color is dark purple.

One of the specimens from Port Galera, Mindoro, has about 30 arms, which are about 170 mm. long; the longest cirri are 30 mm. long and are composed of 34–37 segments. Another has 31 arms 160 mm. long. A third has 33 arms 155 mm. long. A fourth has about 35 arms 150 mm. long. Two others have 38 and 36 arms.

The specimen from *Siboga* station 99 is small with 29 arms; in color it is a uniform dull light yellow.

In the specimen from Pulo Condor as described by Gislén the diameter of the centrodorsal is 6.5 mm. and the cirri are XXXIV, 31–32, from 26 to 28 mm. long. The four basal segments are short, the fifth is as long as broad, the eighth is half again as long as broad, and the distal are one-third again as broad as long. From the thirteenth onward there is a triangular dorsal spine, projecting in the distal half of the segment. The opposing spine is considerably larger than the spine on the segment preceding. The terminal claw is curved, and is a little longer than the segment that bears it. There are 6–8 arms on each postradial series, or about 35 in all. They are 115+ mm. long. The arm bases are widely separated but bear ventrolateral flanges which approach the flanges from the proximal portions of the adjacent postradial series. The synarthrial tubercles are rather inconsiderable, and are not sharply set off. P_1 is 14 mm. long, with 12 segments. P_2 is 18 mm. long, with 14 segments. P_3 is 13 mm. long, with 12 segments. The pinnules following decrease in length. All the proximal pinnules are similar, with smooth and very long cylindrical segments, of which the longest are between three and four times as long as broad. None of them are specially stiffened, but because of the elongated segments they are rather inflexible. The distal pinnules are 10.5 mm. long, with 28 segments. The color is dark brownish violet.

The specimen from *Siboga* station 40 has 28 arms, which are up to about 85 mm. in length. The cirri are XVI, 22–24, 19 mm. long; the eighth or ninth is a transition segment. P_1 is 11 mm. long, with 12 segments. P_2 is 12 mm. long, with 11 segments. P_3 is 9 mm. long, with 9 segments. P_4 is 7 mm. long, with 9 segments. P_5 is 5 mm. long, with 9 segments and is slightly stiffened. The first four pinnules are all stiff and spinelike and are enlarged in proportion to their length. The color is dull whitish with narrow bands of yellow brown on the arms and cirri.

The description given for the species is based upon the type specimen from *Albatross* station 5147. The type specimen of *Stephanometra coronata* from "India" may be described as follows: The cirri are XXII–XXIII, 25–30, 22 mm. long, and resemble those of *S. tenuipinna;* the longest segments are about one third again as long as broad; the ninth, tenth, or eleventh is a well-marked transition segment. The radials project slightly beyond the edge of the centrodorsal. The IBr_1 are oblong, short, about three and one-half or four times as broad as long, with a rounded ventrolateral process in the proximal half, and are not in lateral apposition. The IBr_2 (axillaries) are broadly pentagonal, twice as broad as long, with the lateral edges about half as long as those of the IBr_1 and produced into prominent rounded ventrolateral processes. The IIBr series, IIIBr series, and IVBr series, when present, are 2, resembling the IBr series. All the ossicles of the division series and the first brachials have prominent ventrolateral processes; the synarthrial tubercles are rather prominent. The 33–34 arms are 120 mm. long, in general resembling those of *S. tenuipinna.* P_1 is long, stout, stiff, and spinelike, composed of 14 segments, of which the first two are somewhat broader than long, the third–fifth are about as long as broad, and the remainder become gradually elongated and twice as long as broad distally. P_2 and P_3 are exactly like P_1. P_4 is 10 mm. long, with 10 segments, resembling the pinnules preceding. P_5 is 7 mm. long, spinelike as are the preceding but somewhat slenderer, with 8 segments. The following pinnules decrease gradually in length, P_8 being 5 mm. long, with 8 segments. The succeeding pinnules remain of similar length but decrease in stiffness and increase in the number of segments, P_{13} being 5 mm. long, with 12 segments, which become as long as broad on the third and twice as long as broad distally and only stiffened proximally. The distal pinnules are slender, 9 mm. long.

Remarks.—It is possible that this form will eventually prove to be simply full sized *S. tenuipinna,* but until definite evidence of their identity is available it seems best to keep them separate.

Localities.—Albatross; Port Busin, Barias Island, off the entrance to Ragay Gulf, southeastern Luzon, Philippines; shore; March 8, 1909 [A. H. Clark, 1911, 1912, 1918] (1, U.S.N.M., 35095).

Port Galera, Mindoro, Philippines; Lawrence E. Griffin (8, M. C. Z., 629, 684, 685, 686, 687).

Siboga station 99; anchorage off North Ubian (lat. 6° 07′ 30″ N., long. 120° 26′ 00″ E.); 16–23 meters; lithothamnion bottom; June 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Albatross station 5147; Sulu (Jolo) archipelago, in the vicinity of Siasi; Sulade Island (E.) bearing N. 3° E., 8.4 miles distant (lat. 5° 41′ 40″ N., long. 120° 47′ 10″ E.); 38 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1908, 1909, 1912, 1918, 1921] (1, U.S.N.M., 25442).

Pulo Condor, Cochin China; littoral; Dr. C. Dawydoff [Gislén, 1936].

Siboga station 40; anchorage off Pulu Kawassang, Paternoster Islands; coral reef; 12 meters; April 2, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

"India." [A. H. Clark, 1909, 1911, 1912, 1918] (2, U.S.N.M., 35242; I. M.).
No locality [A. H. Clark, 1912] (fragments, H. M.).

Geographical range.—From southern Luzon, Philippines, southward to the Paternoster Islands (north of Sumbava) and westward to "India" (possibly Ceylon).

Bathymetrical range.—From the shoreline down to 38 meters.

History.—This species was first described under the name of *Himerometra echinus* from a specimen dredged by the *Albatross* at station 5147 in 1908. In the year following another specimen from the *Investigator* collection labeled "India" was described under the name of *Stephanometra coronata.*

In 1911 a specimen of *Stephanometra coronata* was recorded that had been taken by the *Albatross* at Port Busin on Barias Island, and it was noted that this specimen closely resembled the type (with which it had been directly compared) in the Indian Museum at Calcutta.

In a paper on the crinoids of the Hamburg Museum published in 1912, some arm fragments without locality were recorded, and *coronata* was placed in the synonymy of *Stephanometra echinus.*

In my memoir on the crinoids of the Indian Ocean published in 1912, I redescribed the type specimen of *Stephanometra coronata* in detail and figured it and also listed *S. echinus* from the Philippines in 21 fathoms.

In the report on the crinoids of the *Siboga* expedition published in 1918, I recorded *Stephanometra echinus* from stations 40 and 99 and gave notes on the specimens. In this report *coronata* was placed as a synonym under *echinus.*

In 1936 Dr. Torsten Gislén recorded and gave notes on a specimen from Pulo Condor, Cochinchina.

STEPHANOMETRA TENUIPINNA (Hartlaub)

PLATE 45, FIGURES 208, 209

[See also vol. 1, pt. 2, figs. 465, 466 (pinnule tip), p. 266.]

Antedon tenuipinna HARTLAUB, Nachr. Ges. Göttingen, May 1890, p. 178 (description; Matupi, New Britain); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 38 (in key), p. 54 (Matupi, New Britain; detailed description and comparisons), p. 58 (in first section of the *Palmata* group with spiny lower pinnules), p. 113 (in Göttingen Mus.), pl. 3, figs. 28, 30, 34.—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 383 (identity); Crinoids of the Indian Ocean, 1912, p. 37 (identity).

Himerometra tenuipinna A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); vol. 52, 1908, p. 219 (compared with *H. echinus*).

Stephanometra tenuipinna A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (listed); Proc. U. S. Nat. Mus., vol. 36, 1909, p. 399 (*Albatross* station 5174), p. 639 (comparison with *S. coronata*); Vid. Medd. Naturh. Foren. København, 1909, p. 170 (Singapore; description of a specimen), p. 193 (collected at Singapore by Svend Gad); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 383 (identity), p. 397 (New Britain); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 135 (synonymy; off Colombo Light; description; summary of previous records).—H. L. CLARK, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 93 (occurs at Ceylon).—A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 93 (in key; range).

Stephanometra tenuispina GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 20.

Diagnostic features.—The outer cirrus segments have long, sharp, and prominent dorsal spines; there are 16–24 arms 60–70 mm. long; and the cirri have 20 segments.

Description.—The centrodorsal is a convex disk.

The cirri are about XV, about 20, up to 12 mm. in length, and slender. The fifth-eighth segments are rather long (shown in the figure as about twice as long as broad) and those following gradually become shorter, toward the end of the cirri being about as long as broad. From the ninth onward the segments bear a sharp erect median dorsal spine. In addition, each end of the midline of the dorsal surface is produced into a spinelike process that lies parallel with the dorsal surface; of these horizontal spinelike processes the distal is the larger and overlaps the proximal end of the following segment.

The radials are visible, and are partially united laterally. The IBr_1 are entirely free laterally, and are somewhat shorter than the pentagonal axillaries. Of the five postradial series, two have 2 divisions, one has 3, and two have only 1. The IIBr and IIIBr series are 2. The $IIBr_1$ are only partially united with their neighbors. The division series are widely separated laterally. Their lateral edges have no thickenings but are notched. There are no synarthrial tubercles.

The 16 smooth and slender arms are 62.5 mm. long and are composed of rather long brachials. The first brachials are somewhat longer exteriorly than interiorly and are only partially united interiorly. The second brachials have approximately the same form, with a slight posteriorly directed elevation of the middle of the proximal border. The first syzygial pair (composed of brachials 3+4) is slightly longer than broad. The next few brachials are discoidal, and those following are moderately long, short wedge-shaped, distally becoming elongated. The syzygial pairs are long.

Syzygies occur between brachials 3+4 and 16+17 (or in arms arising directly from the IBr axillaries between brachials 9+10), and distally at intervals of 5–8 muscular articulations.

In arms arising from a IBr axillary the first two pairs of pinnules (P_1 and P_a and P_2 and P_b) are equally long and stout, 7 mm. in length. They are stiff and spinelike and are composed of about eight segments, which with the exception of the two basal and of the terminal are much longer than broad. The pinnules of the pair following (P_3 and P_c) are of the same character but are only 4 mm. long, with five segments. The pinnules of the next pair (P_4 and P_d) are the shortest, reaching only 3 mm. in length, and are less stiffened. The succeeding pinnules are very slender, almost hairlike, and become about 7 mm. long. The lower pinnules of the other arms differ in that they are a good deal longer on the outer than on the inner side of the arms.

The disk is 11 mm. in diameter and is only slightly incised. Sacculi are not numerous but are deeply colored and conspicuous; they occur on the pinnules, on the arms, and on the disk.

The color is dorsally light yellowish white; the disk is light brownish gray with a tinge of green.

Notes.—The specimen from Singapore has 24 arms 70 mm. long; the five postradial series bear 8, 2, 2, 7, and 5 arms; in the last one of the arms arises from the IBr axillary, the other branch from the axillary consisting of one IIBr and two IIIBr series, the latter bearing 4 arms. This specimen agrees very well with Hartlaub's description, except that P_3 is nearly as long as P_2, and P_4 is as he describes P_3. The division series have slight lateral projections.

The specimen from off Colombo Lighthouse has 21 arms 50 mm. long. It agrees well with Hartlaub's description, and also with the specimen from Singapore just mentioned. P_1 has 12 segments.

Localities.—*Albatross* station 5174; in the vicinity of Jolo (Sulu), Philippines; Jolo light bearing E., 2.6 miles distant (lat. 6°03′45″ N., long. 120°57′00″ E.); 36 meters; coarse sand; March 5, 1908 [A. H. Clark, 1909, 1912, 1918] (1, U.S.N.M., 35256).

Matupi, New Britain; Dr. O. Finsch [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1912, 1918] (1, Berl M., 5374).

Singapore; Svend Gad [A. H. Clark, 1909, 1912, 1918] (1, C.M.).

Investigator station 152; 11.5 miles S. 83° W. of Colombo Light, Ceylon; 48 meters; sand, shells, and coral; December 12, 1893 [A. H. Clark, 1912; H. L. Clark, 1915] (1, I.M.).

Geographical range.—From the Philippine Islands to New Britain and westward to Ceylon.

Bathymetrical range.—From the shoreline down to 48 meters.

History.—This species was first described by Dr. Clemens Hartlaub in 1890 under the name of *Antedon tenuipinna* from a specimen in the Berlin Museum collected at Matupi, New Britain, by Dr. Otto Finsch. It was redescribed by him and figured in 1891.

In 1907 I placed it in my new genus *Himerometra*, transferring it in 1909 to the new genus *Stephanometra*.

In 1909 I recorded another specimen from *Albatross* station 5174 in the Philippines, and later in the same year I recorded a third from Singapore collected by Svend Gad, the Danish consul at that port. The fourth specimen, dredged by the *Investigator* off Colombo, Ceylon, was recorded in 1912.

In 1912 I mentioned having examined the type specimen in the Berlin Museum, and in 1915 Dr. Hubert Lyman Clark included the species in his list of the echinoderms of Ceylon, other than holothurians, on the strength of the *Investigator* specimen from off Colombo.

STEPHANOMETRA SPINIPINNA (Hartlaub)

Antedon spinipinna Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 179 (description; Amboina); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 11 (collected by Brock at Amboina), p. 39 (in key), p. 58 (in second section of species of *Palmata* group with spiny lower pinnules), p. 61 (Amboina; detailed description and comparisons), p. 113 (in Göttingen Mus.), pl. 4, figs. 42, 44.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 37 (identity).

Himerometra spinipinna A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Stephanometra spinipinna A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (listed); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 132 (synonymy; Amboina); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 93 (in key; range), p. 95 (references; notes; stations 81, 89), p. 272 (listed).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 20.

Diagnostic features.—The outer cirrus segments are wholly without dorsal processes, being merely more or less sharply carinate in the middorsal line; P_1 is stiffened and spinelike, resembling P_2 though smaller and slenderer; there are 12–32 arms 35–150 mm. long; and the cirri have 15–23 segments.

Description.—The centrodorsal is convex, with the bare dorsal pole small and pitted; the cirri are arranged in two irregular marginal rows.

The cirri are XV–XX, about 15, slender and moderately compressed, with smooth segments, of which the fourth–ninth are elongated.

The radials are visible. The IBr_1, which are as long as the free sides of the axillaries, are not in lateral contact. The IBr_2 (axillaries) are pentagonal. Four of the postradial series divide only once, but the fifth—which is markedly smaller than the others, perhaps as a result of regeneration—divides twice. The IIBr series are 2. The ventral edges of the division series are smooth, and synarthrial tubercles are not developed.

There are 12 smooth arms 35 mm. long. The first brachial is rather short and is only partially united with its fellow. The second brachial is a little longer. The first syzygial pair (composed of brachials 3+4) is longer than broad. From the seventh onward the brachials are larger and wedge-shaped, finally becoming more oblong.

The first syzygy is between brachials 3+4, the second is between brachials 9+10, and the distal intersyzygial interval is three or four muscular articulations.

P_1 on arms arising from a IBr axillary is slender, but rather stiff and styliform, and consists of about 12, or at the most 14, elongated segments. P_2 is markedly stouter and a good deal longer; it is quite stiff and spinelike, 6 mm. long, and consists of 8–10 very long segments. P_3 and P_4 decrease in length and are less stiff. P_a is markedly smaller than P_1 and is not styliform. P_b is about as long as P_2. The outer pinnules are moderately long, reaching 7 mm. in length.

The disk is 7 mm. in diameter and is not incised. On the pinnules the sacculi are large and closely set.

The color in alcohol is light yellowish brown, with dark cross bands at the articulations. The disk is gray-brown.

Notes.—The preceding description is taken from Hartlaub's redescription of the type specimen from Amboina.

The specimen from *Siboga* station 81 has 31 arms about 90 mm. long. The cirri are XXIV, 22–23, 20 mm. long. P_1 is 10 mm. long, with 18 segments. P_2 is 12 mm. long, with 12 segments. P_3 is 10 mm. long, with 11 segments. P_4, which is of the same character as the pinnules preceding, is 8 mm. long, with 10 segments.

The example from *Siboga* station 89 has 25 arms about 80 mm. long. The cirri are XXIII, 22–23, from 15 to 20 mm. long. P_1 is 11 mm. long, with 20 segments, of which the first two are about as long as broad, the third is longer than broad, and the remainder are much elongated; the pinnule is slender but very stiff. P_2 is 11 to 12 mm. long, stouter than P_1, with 13 segments. P_3 is 9 mm. long, with 10 segments. P_4, which resembles the preceding pinnules, is 5 mm. long, with 9 segments.

One of the specimens collected by the Danish Expedition to the Kei Islands at Vatek van Toeal has the cirri XXI, 23, from 20 to 23 mm. long. The first segment is very short, the second is about twice as broad as long, the third is slightly longer, the fourth is nearly or quite as long as broad, and those succeeding are longer than broad, the longest (eighth-twelfth) about half again as long as broad, with the terminal only slightly longer than broad. The last 10 or 11 segments have a narrow and very low median dorsal carination. There are 32 arms 140 mm. long. When present IIIBr series are developed on the outer side of the postradial series, occasionally also on the inner side of the IIBr series. P_1 is 11 mm. long with 21 segments, tapering evenly from the base to the tip, somewhat stiffened but not spinelike. The first two segments are broader than long, the third is slightly broader than long, the fourth is longer than broad, the sixth is about twice as long as broad, and the distal are about three times as long as broad. P_2 is 15 mm. long, much stouter than P_1, stiff and spinelike, with 14 segments. The first two segments are nearly half again as broad as long, the third is about one-third again as long as broad, and the remainder are mostly about three times as long as broad, except for the terminal, which is minute and conical. P_3 is 12.5 mm. long, with 12 or 13 segments, similar to P_2 but proportionately smaller. P_4 is 7.5 mm. long, spinelike, but smaller at the base and tapering more rapidly than those preceding, and more slender distally; it is composed of 12 segments of which the outer are very greatly elongated. P_5 is 6 mm. long, with 12 segments, more slender than P_4 and less stiffened. The next two pinnules resemble P_5, and those following are more slender and more flexible. The distal pinnules are 9.5 mm. long, with 20 segments, very slender, with the third and following segments between three and four times as long as broad.

The second specimen from Vatel van Toeal has 30 arms 150 mm. long; each postradial series bears an external IIIBr series on each side. The cirri are XXII, 21–23, from 20 to 25 mm. long. The color of both specimens is deep purple, more or less marked with lighter or darker.

In the larger specimen from the Danish Expedition to the Kei Islands station 3 the centrodorsal is discoidal, thin, with the flat dorsal pole 2 mm. in diameter. The cirrus sockets are arranged in two closely crowded and irregular marginal rows. The cirri are XXIX, 15–17, from 14 to 17 mm. in length. The first segment is three times as broad as long, the second is twice as broad as long, the third is from one-third to one-half again as long as broad, the fourth is nearly or quite twice as long as the median width, and those following slowly decrease in length so that the outermost are about as long as broad, very slightly longer than broad, or, more rarely, slightly broader than long. The segments up to and including the proximal two-thirds of the sixth have a dull surface, the distal third of the sixth segment and the segments following having a highly polished surface. The dorsal profile of the segments following the sixth is moderately convex, the maximum height of the convexity being near the distal end, and their dorsal surface is sharply carinate in the median line. The opposing spine is prominent, conical, arising from the entire dorsal surface of the penultimate segment, with the apex terminal or subterminal; its height is equal to about half the width of the penultimate segment. The terminal claw is slightly longer than the penultimate segment and is moderately and regularly curved. The radials are visible as a narrow line above the rim of the centrodorsal which is wider interradially than elsewhere and is usually interrupted in the midradial line. The IBr_1 are extremely short and bandlike, very slightly longer in the midradial line than laterally, 10 to 12 times as broad as the median length. The very short lateral borders are strongly convergent, making approximately a right angle with each other. The IBr_2 (axillaries) are triangular, nearly or quite twice as broad as long. The very short lateral sides converge strongly proximally to the anterolateral angles of the IBr_1. The anterior edges are rather strongly concave. The proximal portion rises to a prominent though broadly rounded synarthrial tubercle. When the animal is viewed in a plane at right angles to the dorsoventral axis the radial portions of the centrodorsal are seen to have deep V-shaped incisions which make an angle somewhat greater than a right angle accomodating the IBr_1. The IIBr series are 2. The division series and arm bases are rather widely separated laterally. The 14 arms are about 70 mm. long.

The other specimen from station 3 is an exceedingly small 10-armed individual.

Remarks.—In describing *Antedon spinipinna* Hartlaub said that the specimen upon which the description was based is not sexually mature, but nevertheless he felt justified in considering it as a new species because it is so markedly different from the related forms that it is difficult to interpret as a young stage of any one of them.

He said that *spinipinna* is a small and very slenderly built form. P_1 is intermediate in character between P_1 in *S. tenuipinna* on the one hand and *S. spicata* and *S. oxyacantha* on the other. It is rather stiff and styliform and is composed of about 12 elongated segments, but as in *oxyacantha* and *spicata* it is markedly shorter than P_2, which has only 8–10 segments.

Localities.—*Siboga* station 81; Pulu Sebangkatan, Borneo Bank; 34 meters; coral bottom and lithothamnion; June 14, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 89; Pulu Kaniungan ketjil, between northwestern Celebes and Borneo; 11 meters; coral; June 21, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Amboina [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1912, 1918].

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Vatek van Toeal; about 2 meters; March 23, 1922 (2).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 3; 245 meters; March 31, 1922 (2).

Geographical range.—From Borneo southward to the Moluccas and the Kei Islands.

Bathymetrical range.—From the shoreline down to 245 meters.

History.—This species was originally described as *Antedon spinipinna* by Dr. Clemens Hartlaub in 1890 from a single specimen that had been collected by Dr. J. Brock at Amboina. It was redescribed and figured by him in 1891. I placed it in the new genus *Himerometra* in 1907 and removed it to *Stephanometra* in 1909. In 1918 I recorded and gave notes upon two specimens that had been dredged by the *Siboga* at stations 81 and 89.

STEPHANOMETRA OXYACANTHA (Hartlaub)

Plate 47, Figure 217; Plate 48, Figures 218–221

Antedon oxyacantha Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 178 (description; Amboina); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 6 (with *A. ludovici* the most usual species of *Antedon* at Amboina), p. 11 (collected by Brock at Amboina), p. 15 (at Amboina next commonest to *A. ludovici*), p. 39 (in key), p. 55 (Amboina; detailed description and comparisons), p. 58 (in second section of the *Palmata* group with spiny lower pinnules), p. 113 (in Göttingen Mus.), pl. 3, figs. 35, 37.—PFEFFER, Abh. Senck. naturf. Ges., vol. 25, 1900, p. 85 (Ternate).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity); Crinoids of the Indian Ocean, 1912, p. 37 (identity).

Himerometra oxyacantha A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Stephanometra oxyacantha A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (listed); Notes Leyden Mus., vol. 33, 1911, p. 183 (Amboina); Rec. Australian Mus., vol. 9, No. 1, 1912, p. 82 (detailed description of a specimen from Ugi, Solomon Islands); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity), p. 19 (Amboina; description of one of the specimens recorded by Hartlaub); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 132 (synonymy; Amboina; Solomon Islands).—REICHENSPERGER, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 83 (Amboina), p. 102 (characters of the specimens).—A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 94 (in key; range; references; notes; station 99; Enkhuizen Island), pp. 272, 276 (listed).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.—A. H. CLARK, Temminckia, vol. 1, 1936, p. 302 (near Bongao; near Koepang; Obi latoe; Amboina; Lembeh Strait, Celebes; notes).

Diagnostic features.—The outer cirrus segments are wholly without dorsal processes, being merely more or less sharply carinate in the middorsal line; P_1 is flexible, flagellate, delicate, and slender, much smaller and weaker than P_2; P_2, P_3, and P_4, and sometimes also P_5, are much enlarged, stiffened, and spinelike, progressively decreasing in length; there are 24–32 (usually 30) arms 100–150 mm. long; and the cirri have 23–29 (usually about 25) segments.

Description.—The centrodorsal is moderate in size, discoidal, with the bare polar area slightly concave, 2.5 mm. in diameter.

The cirri are XXXII, 23–24, from 20 to 25 mm. long. The first segment is short, the next two are about twice as broad as long, and those following gradually increase in length, becoming about as long as broad on the fifth or sixth. The next three or four segments are slightly longer than broad, and those succeeding very gradually decrease in length, becoming about half again as broad as long distally. The segments in the proximal half of the cirri are slightly constricted centrally and have somewhat prominent ends, and those in the distal half are slightly compressed laterally and may be bluntly carinate. The opposing spine is median to terminal, blunt, and triangular, equal in height to one-quarter the width of the penultimate segment. The terminal claw is somewhat longer than the penultimate segment and is moderately slender, evenly tapering, and moderately curved.

The radials are visible only in the interradial angles. The IBr_1 are very short, in contact basally, about four times as broad as long. The IBr_2 (axillaries) are short and broad, almost triangular, twice as broad as long, with the lateral edges swollen and produced into rounded lateral processes. The IIBr series are 2; the $IIBr_1$ are interiorly united for about three-quarters of their length. The elements of the division series and the first brachials have rounded lateral processes. In the specimen described the IIIBr series are present exteriorly on three postradial series.

The 24 arms are about 120 mm. long. The first two brachials are short, wedge-shaped, twice as broad as long exteriorly, the first interiorly united for most of their length. The first syzygial pair (composed of brachials 3+4) is half again as broad as long. The next three brachials are oblong, slightly more than twice as broad as long, those succeeding are wedge-shaped, soon becoming almost triangular, twice as broad as long, distally gradually becoming less and less obliquely wedge-shaped, and in the terminal portion of the arm longer, about as long as broad.

Syzygies occur between brachials 3+4, again from between brachials 10+11 to between brachials 15+16 (usually between brachials 14+15 or 15+16), and distally at intervals of from 7 to 10 (usually 8) oblique muscular articulations.

P_1 is 11.5 mm. long, slender, evenly tapering and becoming very slender distally, with 23 segments of which the first is about half again as broad as long and those following gradually increase in length, becoming about as long as broad on the third and twice as long as broad, or somewhat longer, distally. P_2 is much stouter than P_1, stiff and spinelike, 15 mm. long, with 12 segments of which the first two are subequal, about half again as broad as long, the third is half again as long as broad, and the remainder are about two and one-half times as long as broad. P_3 is 12 mm. long, resembling P_2, and is composed of about 10 segments, of which the distal are much longer than those of the preceding pinnule. P_4 is 7 mm. long, resembling P_3 but not quite so stout, and is composed of 9 segments. P_5 is smaller than P_4 basally and becomes very slender distally; it is 6 mm. long and is composed of 13 segments. The following pinnules resemble P_5, but rapidly become less stiffened basally. The distal pinnules are 9 mm. long.

Notes.—The preceding description was drawn up from the specimen from Ugi, Solomon Islands, in the collection of the Australian Museum.

In one of the specimens from Port Galera, Mindoro, with 30 arms P_1 is 17 mm. long, with 28 segments, and is very slender and flagellate. P_2 is 23 mm. long, with 18 segments. P_3 is 15 mm. long, with 13 segments. P_4 is 8 mm. long, with 11 segments, resembling the immediately preceding pinnules but smaller. On another arm P_2 is 20 mm. long, with 16 segments. P_3 is 16 mm. long, with 14 segments. P_4 is 9 mm. long, with 11 segments. On a third arm P_2 is 22 mm. long, with 18 segments. P_3 is 16 mm. long, with 14 segments. P_4 is 9 mm. long, with 12 segments.

Another specimen has 30 arms 135 mm. long, and the longest cirri 26 mm. long with 24 segments. Two others have 30 arms 150 mm. long, and 32 arms 140 mm. long. Of the remaining specimens one has 32 arms and five have 30 arms.

The specimen from *Siboga* station 99 has 31 arms about 110 mm. long. The cirri are XXIV, 24–29 (usually 24–26), 25 to 30 mm. in length. P_1 is 12 mm. long, very delicate, with 20 segments, of which the outer are three times as long as broad. P_2 is 15 mm. long, stiff and spinelike, with 13 segments. P_3 is 14 mm. long, with 12 segments, and resembles P_2. P_4 is 9 mm. long, with 10 segments, and resembles P_2 and P_3, but is proportionately smaller. P_5 is 6 mm. long, with 9 segments, and is of the same character as the pinnules preceding. P_6 is weak and delicate, 4.7 mm. long, with 9 segments. The immediately following pinnules are similar to P.

One of the two specimens from near Bongao has 19 arms 140 mm. long. P_2 is 18 mm. long, with 15–17 segments. P_3 is 10–12 mm. long, with 11–13 segments. P_4 resembles P_3, but is only slightly longer than the pinnules succeeding, 7 mm. long, with 13 segments. All but one of the IIBr series are present. The other specimen is similar. It has 20 arms, of which 8 are in process of regeneration. All the IIBr series are present.

In the specimen from near Koepang P_2, P_3, and P_4 are stiffened and enlarged. The cirri have 19–21 segments.

The specimen from Obi latoe has 27 arms 90 mm. long. P_2 is 13 mm. long, with 11 segments. P_3 is 10 mm. long, with 9 segments. P_4 is similar to P_3, 7 mm. long, with 8 segments.

The example from Lembeh Strait, Celebes, is small and is in process of adolescent autotomy; it has 20 arms.

The specimen collected by the *Willebrord Snellius* at Amboina has 30 arms 120 mm. long. The six arms on each postradial series are arranged in 2, 1, 1, 2 order. The cirri are 30–33 mm. long, with 25 or 26 segments. P_1 is 23 mm. long, with 39 segments, very flexible, tapering more rapidly in the proximal fourth than beyond. P_2 is 30 mm. long, with 23 segments. P_3 is 22 mm. long, with 18 segments. P_4 is 18 mm. long, with 19 segments. P_5 resembles P_4 and is 12 mm. long, with 15 segments.

The 10 specimens collected by Dr. J. Brock at Amboina were thus described by Hartlaub: The centrodorsal is thick, with convex sides and sometimes with a markedly pentagonal lower border. The free dorsal pole is usually rather small and is marked with small pits. The cirri are arranged in two and a partial third irregular marginal rows. The cirri are XXX–XXXV, about 25, from 18 to 28 mm. long, rather slender and laterally compressed. The fifth-eleventh segments are elongated, and often have thickened ends. In the proximal half of the cirri the ventral side of the distal ends of the segments tends to overlap the proximal end of the segments following. There are no dorsal tubercles or spines with the exception of the opposing spine. The radials are entirely concealed. The IBr_1 are as long as the free sides of the shortly pentagonal IBr_2 (axillaries) and are entirely free laterally. The IIBr and IIIBr series are 2. The IIIBr series occur only on the outer sides of the postradial series so that as a rule each of the latter bears 6 arms. Slight synarthrial tubercles are present. The elements of the division series have slight thickenings on their lateral edges. The two ossicles immediately following each axillary are partially united interiorly. The arms are usually 30 in number and are 100 to 140 mm. long. The brachials are short. The first seven or eight are thick discoidal, the 30 or so following are triangular with slightly overlapping distal ends, and those succeeding are short wedge-shaped, later becoming short discoidal, toward the ends of the arms about as long as broad, and finally somewhat elongated. Syzygies occur between brachials 3+4, again usually from between brachials 13+14 to between brachials 26+27 (often at about the twenty-fourth brachial), and distally at intervals of usually 8–11 muscular articulations. On arms arising directly from a IBr axillary the second syzygy is between brachials 9+10 and the distal intersyzygial interval is four or five muscular articulations.

The pinnules of the first pair are slender and flagellate, but those of the three or four following pairs are much thicker, stiff, straight, more or less sharp at the tip, and spinelike. P_1 is usually longer on the outer arms of each postradial series than on the inner. It measures up to 15 mm. in length and is composed of 20–27 cylindrical segments which, with the exception of the basal, are longer than broad. P_a is a good deal shorter than P_1. P_2 and P_3, the two following stiff and spiniform pinnules on the outer side of the arms, are usually markedly longer, and may reach 20 mm. in length. Sometimes they are both of the same size, but their relative length varies, and P_2 may be either longer or shorter than P_3. Both pinnules are composed of 9–15 (usually about

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12) segments, of which the middle are twice, and the distal, with the exception of the two last, are three times as long as broad. The two following pinnules decrease markedly in length and in the number of their component segments. At least the first of these possesses the stiff and spinelike character of those preceding. The maximum length of the distal pinnules is 10 mm. The length and form of the proximal spiniform pinnules are somewhat subject to individual variation. They are always longer on the outer side of the arms than they are on the inner. The disk is 15 mm. in diameter and is incised. Sacculi are numerous on the disk, arms, and pinnules. The dorsal skeleton is chocolate-brown, with the central region sometimes somewhat lighter; or the arms are grayish black with broad bands of light brown and the central region also light brown; or the color is light brown with very dark cross stripes at the brachial articulations. The disk is dark brown.

I have examined two of the specimens that served as the basis for Hartlaub's description, one at Leyden and one at Hamburg.

The specimen at Hamburg has 30 arms 140 mm. long. The centrodorsal is low hemispherical, 6 mm. in basal diameter, with the dorsal pole small and flat, 2.5 mm. in diameter; the cirrus sockets are arranged in three closely crowded irregular rows. The cirri resemble those of *S. monacantha* or *S. tuberculata;* the longest proximal segments are twice as long as broad or slightly longer, and the segments in the outer third or half of the cirri are about as long as broad.

This is a more robust form than *S. tuberculata* or *S. monacantha*, and P_2, P_3, and P_4 are similar. In the specimen at Hamburg P_1 is 12 mm. long, slender, with 21 segments. P_2 is 13–16 mm. long, enlarged, stiffened, and spinelike, with 13 or 14 segments. P_3 is 13–16 mm. long, with 12 or 13 segments, and is similar in every way to P_2. P_4 is 9 mm. long, similar to the preceding pinnules, but proportionately smaller, with 10 segments. P_5 is 6 mm. long, similar to P_4 but proportionately smaller, with 10 segments. The following pinnules are small and weak, 4.5 or 5 mm. in length, gradually increasing in size outwardly. The distal pinnules are 9 mm. long, with 20 segments, and very slender.

The specimen collected by Professor Strubell at Amboina, according to Dr. August Reichensperger, has the cirri XXXII, 22–26, from 22 to 30 mm. long. With the exception of the first and the last the segments are longer than broad, and there are no dorsal spines. There are 29 arms 130 mm. long. P_1 is slender, somewhat stiffened though filiform, and is composed of 22–25 segments. P_2 to P_5 are stiff, styliform, and sharp-pointed. P_2 consists of 15 segments and reaches 21 mm. in length. The following pinnules measure 16, 11, and 7 mm. in length and are composed of 12, 10, and 9 segments. The structure of the arms, etc., agrees with that given in Hartlaub's description, but the lateral thickenings of the ossicles from the IBr axillary to the last axillary are very pronounced, and they differ from the adjacent parts in their lighter color. The color is chocolate-brown, with the distal portions of the arms abruptly much lighter.

One of the specimens from the Danish Expedition to the Kei Islands taken at Toeal has 30 arms about 130 mm. long; the cirri have 23–25 segments. The other specimen has 29 arms about 110 mm. long; there are nine IIIBr series, all of them on the outer sides of the postradial series so that the arms are developed in 2,1,1,2 order.

Of the four specimens collected by the *Siboga* at Enkhuizen Island, one has 30 arms 135 mm. long and the cirri XXXV, 24–25, 30 mm. long. P_1 is 11 mm. long, with 20 segments, very slender and delicate, with the outer segments three times as long as broad. P_2 is 15 mm. long, stiff and spinelike, with 12 segments. P_3 is 14 mm. long, with 11 segments, and resembles P_2, but is slightly more slender. P_4 is 10 mm. long, with 11 segments, and resembles P_3. P_5 is 7 mm. long with 9 segments and is of the same character as the immediately preceding pinnules. The following pinnules are short. The other specimens are similar.

Localities.—Port Galera, Mindoro, Philippines; Lawrence E. Griffin (23, M.C.Z., 615, 630, 690–696).

Siboga station 99; anchorage off North Ubian, west of Jolo (Sulu), Philippines (lat. 6°07′30″ N., long. 120°26′00″ E.); 16–23 meters; lithothamnion bottom; June 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Ugi, Solomon Islands [A. H. Clark, 1912, 1918] (1, Austr. M.).

Ternate, Moluccas [Pfeffer, 1900; A. H. Clark, 1918].

Anchorage near Bongao, Tawi-tawi Islands; 27 meters; *Willebrord Snellius*, September 9, 1929 (2, L.M.).

Near Koepang; 6–15 meters; *Willebrord Snellius*, December 4, 1929 (1, L.M.).

Obi latoe; shore and reef; *Willebrord Snellius*, April 23–27, 1930 (1, L.M.).

Lembeh Strait, Celebes; *Willebrord Snellius*, September 25, 1930 (1, L.M.).

Amboina; *Willebrord Snellius*, September 17, 1930 (1, L.M.).

Amboina; Dr. J. Brock [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1918] (2, H.M., L.M.).

Amboina; Professor Strubell [Reichensperger, 1913; A. H. Clark, 1918].

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; Vatek van Toeal; about 1–2 meters; rocky coast; March 27, 1922 (2).

Siboga, Enkhuizen Island, near Batavia, Java [A. H. Clark, 1918] (4, U.S.N.M., E. 469; Amsterdam Mus.).

Geographical range.—From the Philippines to the Solomon Islands and the Moluccas, and westward to Java.

Bathymetrical range.—From the shoreline down to 16 (?23) meters.

Occurrence.—Hartlaub said that the commonest comatulids at Amboina seem to be this species and *Heterometra amboinae* ("*Antedon ludovici*").

History.—This species was first described as *Antedon oxyacantha* by Dr. Clemens Hartlaub in 1890. In 1891 he redescribed and figured it, and compared it in detail with related species. It was recorded by Prof. Georg Pfeffer from Ternate in 1900.

On my establishment of the new genus *Himerometra* in 1907, *oxyacantha* was included in it, but it was removed to the new genus *Stephanometra* in 1909.

In 1911 I published notes on one of Hartlaub's specimens from Amboina, which I had seen in the Leyden Museum, and in 1912 I published notes on another that I had examined at the Hamburg Museum. In 1912 also I described in detail a specimen in the Australian Museum from Ugi in the Solomon Islands.

Dr. August Reichensperger in 1913 described a specimen collected at Amboina by Professor Strubell, and in 1918 I recorded and gave notes upon five specimens collected by the *Siboga* at station 99 and at Enkhuizen Island.

STEPHANOMETRA SPICATA (P. H. Carpenter)

Plate 49, Figures 223, 224; Plate 91, Figure 447

Antedon spicata P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 190 (description; Banda Sea).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula).—Bell, Proc. Linn. Soc. New South Wales, vol. 9, 1884, 1885, p. 497 (Ugi); Proc. Zool. Soc. London, 1888, p. 389, footnote 5 (collected by Dr. Anderson at Mergui).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 225; Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 305 (specific formula), p. 310 (King Island, sublittoral; characters of the specimen; comparison with *indica* and *tuberculata*), pl. 27, figs. 3–5.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 38 (in key), p. 58 (in second section of species of the *Palmata* group with spiny lower pinnules; characters).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed.)—A. H. Clark, Rec. Australian Mus., vol. 9, No. 1, 1912, p. 81 (known from Ugi); Crinoids of the Indian Ocean, 1912, pp. 35, 36 (of P. H. Carpenter 1888 and 1889=*Stephanometra spicata*), p. 41 (of Bell, 1909=*Cenometra emendatrix*), p. 136 (B.M., MS.=*Stephanometra monacantha*).

Antedon tuberculata von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, pp. 4, 6 (station 174; myzostomes).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 232 (description; station 174, B, C, or D), pl. 45, figs. 2, 3; Journ. Linn. Soc. (Zool.), vol. 21, 1889, pp. 310, 311 (comparison with *A. spicata*).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 38 (in key), p. 58 (in second section of species of *Palmata* group with spiny lower pinnules), p. 59 (characters).—Bell, Willey's Zool. Results, pt. 2, 1899, p. 133 (Lifu).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 385 (of Hartlaub, 1891 = *Stephanometra tuberculata*); Crinoids of the Indian Ocean, 1912, pp. 35, 39 (of P. H. Carpenter, 1888, and Bell, 1899 = *Stephanometra tuberculata*).

Antedon ?spicata Bell, Proc. Zool. Soc. London, 1894, p. 396 (Macclesfield Bank, 20–35 fathoms).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 38 (identity).

Himerometra spicata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra tuberculata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Stephanometra spicata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (listed); Notes Leyden Mus., vol. 33, 1911, p. 176 (= *Antedon spicata* P. H. Carpenter), p. 183 (Banda Sea; redescription of the type); Rec. Australian Mus., vol. 9, No. 1, 1912, p. 84 (Bell's record from Ugi); Crinoids of the Indian Ocean, 1912, pp. 35, 36 (identity of previous records), p. 132 (synonymy; Banda Sea; Ugi; detailed description of the type; comparison with *S. tuberculata*); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 94 (in key; range), p. 95 (references; notes; station 99), p. 272 (listed), pl. 7 (colored figure).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 41, 44 (reversion), p. 78 (syzygies), p. 88 (articulations), p. 283, figs. 53, 54, p. 67, fig. 70, p. 75, fig. 99, p. 87, figs. 154–157, p. 98.—A. H. Clark, Proc. Biol. Soc. Washington, vol. 47, 1934, p. 11 (Blakang Mati; notes).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 3 (Macclesfield Bank), p. 4 (French Indochina), p. 5 (range), p. 11 (locality; notes).—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 87 (listed), p. 88 (*Mabahiss* station 10; notes; range), p. 100 (range), p. 104.

Stephanometra tuberculata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (listed); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 19 (compared with *S. oxyacantha*), p. 20 (Ruk; Pitilu; Pelew Islands; descriptions of specimens); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 385 (*Antedon tuberculata* of Hartlaub, 1891, is this species), p. 396 (New Guinea; detailed description; no locality; descriptions of 2 specimens); Crinoids of the Indian Ocean, 1912, pp. 35, 38, 39 (identification of previous records), p. 133 (synonymy; localities; description of the type specimen); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 28 (published references to specimens in the B. M.; localities represented by the specimens).—Hartmeyer, Mitt. zool. Mus. Berlin, vol. 8, Heft 2, 1916, p. 235 (New Guinea, No. 2971).

Stephanometra marginata A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 169 (Singapore; description of a specimen), p. 170 (a typical *Stephanometra*); Crinoids of the Indian Ocean, 1912, pp. 34, 40, 41 (identity of previous records), p. 135 (synonymy; localities; notes on the type specimen).—H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 93 (occurs at Ceylon).

Stephanometra sp. A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 252 (New Caledonia; notes).

Stephanometra stypacantha H. L. Clark, Carnegie Inst. Washington Publ. 212, 1915, p. 103 (description; Mer).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 94, footnote 2 (synonym of *S. spicata*).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 8 (collected by the Carnegie Exped., 1913), p. 22 (Mer; notes; color in life), pp. 192 ff. (range in Australia), pl. 22, fig. 4, pl. 36, figs. 3, *a-e*.

Diagnostic features.—The outer cirrus segments are wholly without dorsal processes, being merely more or less sharply carinate in the middorsal line; P_1 is flexible, flagellate, delicate, and slender, much smaller and weaker than P_2; P_2 and P_3 are much enlarged, stiffened, and spinelike, P_3 being smaller than P_2 though otherwise similar to it; P_4 is small and weak like the pinnules following; there are 14–33 (usually about 30) arms 70–120 (most commonly about 100) mm. long; and the cirri have 18–28 (usually 20–25) segments.

Description.—The centrodorsal is discoidal, usually rather thin though sometimes thick, with strongly sloping sides and a small concave dorsal pole, more rarely low hemispherical, with an approximately flat, small dorsal pole. The cirrus sockets are arranged in from one and a partial second to three or more, but usually in two, irregularly alternating marginal rows.

The cirri are XXV-LII (usually XXV-XXXV), 18–28 (usually 20–25), 15 to 30 mm. (usually 20–25 mm.) long. The basal segments are short, and those following gradually increase in length to the fourth or fifth, which with a few of those succeeding are usually from one-third to one-half again as long as broad but vary from slightly broader than long to twice as long as broad. The following segments gradually decrease in length so that the distal are usually somewhat broader than long, though they may be as long as broad, or even slightly longer than broad. The short outer segments are rather strongly compressed laterally and bear a more or less well developed keel in the middorsal line. The opposing spine is prominent, subterminal, and directed obliquely forward. The terminal claw is slightly longer than the penultimate segment and is stout and rather strongly curved.

The radials are wholly concealed, or their distal ends are just visible beyond the rim of the centrodorsal. The anterolateral angles of adjacent radials are separated by a notch. The IBr_1 are short, oblong, rather strongly convex dorsally, and quite free laterally. The IBr_2 (axillaries) are broadly pentagonal and are from about half again to more than twice as long as the IBr_1. The IIBr, IIIBr, and IVBr series are 2. The IIIBr series are usually developed only on the outer sides of the postradial series so that typically each postradial series bears six arms arranged in 2, 1, 1, 2 order. The ossicles immediately following each axillary are almost completely united interiorly. The division series are well separated, rather narrow, and rather strongly convex. More or less well developed synarthrial tubercles are present. The ventrolateral borders of all the ossicles from the IBr_1 to the second brachials inclusive bear usually small irregular projections toward the ventral side; but they may be produced into prominent, though narrow, flangelike extensions.

The arms are 14–33 (usually about 30) in number and are 70 to 120 mm. (most commonly about 100 mm.) in length. They consist of about 120–150 brachials. The first two brachials are wedge-shaped, the second having more oblique ends than the first. The first syzygial pair (composed of brachials 3+4) is about as long as broad, or slightly broader than long. The next four or five brachials are oblong, and those succeeding are wedge-shaped or even triangular, broader than long, with very slightly produced and overlapping distal ends, gradually becoming quadrate and more discoidal again in the middle of the arm.

Syzygies occur between brachials 3+4, again from between brachials 8+9 to between brachials 22+23 (usually from between brachials 13+14 to between brachials 16+17, and on arms arising from a IBr axillary with an extra one between brachials 8+9 or 9+10), and distally at intervals of 4–11 (usually 6–8) muscular articulations.

P_1 is weak, slender, and flagellate. It varies in length from half as long as P_2 to quite as long as the latter but is usually two-thirds to three-fourths the length of P_2. It measures 4 to 14 mm. in length but is usually between 9 and 11 mm. long. It is composed of 14–27 (usually 17–22) segments, of which the first is twice as broad as long, the third is about as long as broad, and those following gradually increase in length so that the distal are three times as long as broad or even longer.

P_2 is stouter, usually much stouter, than P_1, usually markedly longer and never shorter, composed of fewer segments, very stiff and styliform with a sharp spinelike tip, straight and erect, recurved at the base, or recurved for its entire length. It varies from 8 to 17 mm. in length and is usually between 10 and 15 mm. long. It is composed of 9–18 (usually 10–15) segments of which the first is twice as broad as long, the third is about as long as broad or somewhat longer than broad, and most of the remainder, except the terminal, are three times as long as broad or even longer. The terminal 4–6 segments are sometimes abruptly less in diameter than those preceding, so that the pinnule appears to have a regenerated tip. Although three instances of this have been reported from widely separated regions (the Philippines, Singapore, and Ceylon), it may be the result of injury or of a diseased condition.

P_3 resembles P_2 in character, but it is always shorter. It is commonly about two-thirds as long as P_2, but may be longer and even very nearly as long as the latter. Its length varies from 5 to 14 mm., being usually between 8 and 12 mm. Its stoutness in relation to P_2 is proportionate to the length of the two pinnules. P_3 usually is composed of one to four fewer segments than P_2, but occasionally it has the same number of segments, and rarely it has from one to three more. The segments number from 8 to 14 and are most commonly 10–12. They are of the same proportions as the segments of P_2.

P_4 is variable. It is typically and usually small, slender,. and flexible like the following pinnules and thus very different from the enlarged and styliform P_2 and P_3. But it may be slightly longer than the succeeding pinnules and somewhat stiffened, and in extreme cases it may, though much smaller than P_3, be nearly three-fourths of its length and more or less like it distally, differing more from the slender, weak, and flexible P_5 than it does from P_3. It varies from 3 to 9 mm. in length and is composed of 8–12 (usually 9–11) segments.

Notes.—The specimen from the Macclesfield Bank is smaller than the type of Carpenter's *Antedon tuberculata* from *Challenger* station 174 but is otherwise exactly like it.

The specimen from Annam, according to Gislén, has the cirri 11–14 mm. long, with 19–21 segments. There are no dorsal spines, but an opposing spine is present.

IIIBr series are developed on the outer sides of the postradial series. The division series are constricted ventrolaterally at the articulations, the lateral margins thereby acquiring a knobby appearance. There are 28 arms. P_2 and P_3 are stiffened. P_2 is the longest pinnule and is composed of 13 segments. P_3 has 10 segments. The disk is much incised, without calcareous granules, white spotted with brown. The color otherwise is white, banded with brown, especially at the articulations.

Of the three specimens from Bantayan Reef, Cebu, one has 30 arms, one has about 30 arms, and the third is fragmentary. In the specimen with 30 arms P_1 is 11 mm. long with 20 segments, P_2 is 17 mm. long with 15 segments, and P_3 is 11 mm. long with 14 segments resembling P_2 but proportionately smaller.

The specimen from *Siboga* station 99 has 20 arms 85 mm. long. The cirri are XXV, 22–23, 20 mm. long. P_2 is comparatively short, 11 mm. long, with 15 segments. P_3 is 8 mm. long, with 13 or 14 segments.

The specimen from the Pelew Islands has 30 arms 115 mm. long. The cirri are 25 to 30 mm. long and consist of 20–23 segments, of which the longer proximal are twice as long as broad and the shorter distal are slightly longer than broad. The cirri are moderately slender and very long as in the specimen from Pitilu (see below), though they are not quite so slender as in that individual. P_1 is 13 mm. long, slender and flagellate, with 26 segments. P_2 is 15 mm. long, very stiff and spinelike, but slightly more slender than usual, with 13 segments. P_3 is 12 mm. long, with 11 segments, and resembles P_2. P_4 is 9 mm. long, with 11 segments, resembling P_3 but much more slender.

The example from Ruk has 31 arms 85 mm. long. The cirri are about 23 mm. long and consist of 26–27 segments, of which the longest are usually not quite so long as broad, rarely as long as broad, and the outermost 9 to 12 are broader than long. The enlarged lower pinnules have 10 or 11 segments. P_4 is more like the following pinnules than it is in the specimen from Pitilu (see below), and the shorter and somewhat stouter cirri with shorter segments give this individual a somewhat different appearance.

The specimen from New Guinea has 15 arms about 60 mm. long. One IIIBr series is developed externally. P_2 is 9 mm. long, with 10 greatly elongated segments. P_3 is similar to P_2 but smaller, 6 mm. long, with 8 segments. P_4 has 8 segments, of which the outer resemble those of the preceding pinnules; it is 4 mm. long and is slightly stiffened. P_2 and P_3 are comparatively slender, possibly because of the small size of the animal.

The specimen from Pitilu, Admiralty Islands, has 27 arms 95 mm. long. The cirri are XXX, 20–23, from 25 to 27 mm. long. The longest segments of the longer cirri are twice as long as the median width, or somewhat longer. P_1 is 10 or 11 mm. long, weak, and slender, with 17 or 18 segments. P_2 is stout and spinelike, 10 mm. long, with 10 or 11 segments. P_3 is similar to P_2 but slightly smaller, 9 to 10 mm. long, with 9 or 10 segments. P_4 is 7 mm. long, smaller than the preceding pinnules, but stiffened. P_5 is 5 mm. long, with 10 segments. The following pinnules are similar but slightly smaller and weaker. The distal pinnules are very slender, 9 mm. long, with 18 or 19 segments.

The specimen from *Challenger* station 174 was described by Carpenter as representing a new species, which he called *Antedon tuberculata*. According to Carpenter the centrodorsal is saucer-shaped. The cirri are about XL, 20–25, rather stout with tolerably uniform segments, few of which are longer than broad; there is a small opposing spine. The radials are concealed by the centrodorsal. The IBr_1 are short and rather convex dorsally and are not united laterally. The IBr_2 (axillaries) are more than twice as long as the IBr_1 and are broadly pentagonal. The articulation between the IBr_1 and IBr_2 is rather tubercular. The division series are well separated, and the postradial series may divide three times. The IIBr and IIIBr series are 2 and bear synarthrial tubercles. IIIBr series are usually developed only on the outer sides of the postradial series, so that each postradial series bears six arms arranged in 2, 1, 1, 2 order. The ventrolateral borders of all the ossicles of the division series bear small tubercles, which project somewhat toward the ventral side. The 31 arms are about 90 mm. long and consist of 120 or more brachials, the first 8 or 10 of which are thick disks, those following being shortly triangular and later becoming more discoidal again. The first syzygy is between brachials 3+4, the second from between brachials 8+9 to between brachials 22+23, generally about brachials 13+14 or 15+16, and the distal intersyzygial interval is from 6 to 11, usually 8, muscular articulations.

The pinnules of the first pair (P_1 and P_a) are about 9 mm. long and consist of some 25 longish segments. The pinnules of the second pair (P_2 and P_b) are much stouter and very stiff and tapering, reaching 15 mm. in length; they are composed of about 12 segments all of which, except for those at the two ends, are much longer than broad. The pinnules of the third pair (P_3 and P_c) are of the same character but are rather shorter than the pinnules of the second pair. The pinnules of the fourth pair (P_4 and P_d) are much smaller and less stiff. The disk is lost, but was probably about 12 mm. in diameter. Sacculi are abundant along the ambulacral grooves of both arms and pinnules. The color in alcohol is purplish white with occasional dark purple bands, the ventral perisome greenish gray.

I examined this specimen at the British Museum in 1910. There are 30 arms. P_1 is slender and flexible, becoming very slender and flagellate distally. P_2 is much enlarged, stiff and spinelike, nearly half again as long as P_3, with 12 segments. P_3 resembles P_2 but is shorter and slightly less stout. P_4 is very short and small but is more or less stiffened. P_5 resembles P_4.

Carpenter said that *tuberculata*, as well as *spicata* (from the Banda Sea; see beyond) and *indica* (p. 439), is distinguished by the characters of the pinnules of the second pair which are considerably longer than the pinnules of the first pair, though composed of a smaller number of segments, which, however, are of very large size, some of them reaching 1.5 mm. The segments decrease gradually in diameter from the base to the tip of the pinnule so as to give the latter a remarkably stiff and tapering appearance. He said that there is some indication of this in *marginata* (p. 447), but its large pinnules are less stiff with relatively shorter segments, which are more uniform in diameter so that the pinnules lack the tapering and styliform appearance which is so marked in *spicata* and *tuberculata*. In *marginata* also the cirri are both smaller and have fewer segments than those of *tuberculata*, while the IBr_1 and IBr_2 (axillaries) are more nearly equal in length, and portions of the radials are visible.

Carpenter noted that *tuberculata* has many points of resemblance with *spicata* from the Banda Sea (see beyond), and it may be that a larger knowledge of both types will eventually lead to their union He said that in *tuberculata* the cirri are both considerably more numerous than in *spicata* and reach a larger size, though the actual number of segments composing them is the same in both forms. The IBr_1 of *tuberculata* are short as compared with the axillaries, not reaching half their length, while in *spicata* the axillaries are short as compared with the IBr_1. In *spicata* the arms are also longer than in *tuberculata*, and the muscle plates are more prominent at the sides of the ambulacra.

Of the two specimens from Lifu one has 30 arms 120 mm. long, and the cirri LII, 25–28 (usually 25), 20 to 30 mm. long. P_2 has 15 segments, and P_3 has 11 or 12 segments. The other is similar.

In the specimen from New Caledonia the cirri are XVI, 18–19. There are 24 arms. P_2 is much enlarged and very stiff and spinelike. P_3 resembles P_2 but is slightly smaller. P_4 and the pinnules following are short but stiffened.

The specimen from Mer was described by Dr. Hubert Lyman Clark as a new species under the name of *Stephanometra stypacantha*. He said that the centrodorsal is large, thick, slightly convex, and almost completely covered by the cirri. Its diameter is 3.5 mm., but the bare dorsal pole is less than 1 mm. across. The cirri are XXXIII, 18, about 12 to 13 mm. long, and are distally very distinctly compressed. The basal three or four and the terminal half dozen segments are more or less shortened, and the others are longer than broad. The terminal six or seven segments may show a longitudinal keel dorsally, but this is never marked. The opposing spine is distinct but small. The division series are all 2. The axillaries are pentagonal, nearly as long as broad. The division series have no lateral processes, and no synarthrial tubercles. The 16 arms are about 70 mm. long. At the base of the arm and distally the brachials are quadrate, but the seventh-thirtieth (or thereabouts) are more or less markedly wedge-shaped. Syzygies occur between brachials 3+4 and 16+17 and then at intervals of seven to nine muscular articulations. Sometimes they occur between brachials 9+10 and 14+15 (or 15+16) and then at intervals of six or seven muscular articulations.

P_1 is about 4 mm. long, flagellate, with 14 segments, of which the basal are stout, but the distal are long and very slender. P_a is similar but much smaller. P_2 is very rigid, sharp, and spinelike, 8 mm. long, with 9 segments, of which 3 to 6 are greatly elongated, three times or more as long as broad, and the ninth is minute. P_b is similar but is evidently smaller in every way. P_3 is similar to P_2 but is only 5 or 6 mm. long. P_c is similar but much smaller. P_4 is more flagellate, less than 3 mm. long, and with only 8 segments. P_d is similar, and about equal, to P_4. The succeeding pinnules gradually become longer but do not exceed 6 or 7 mm., with 14 or 15 segments. All the pinnules are more or less cylindrical and are composed of smooth segments.

Dr. Clark said that this species seems to be very well characterized by the numerous, few-jointed, nearly smooth cirri, the absence of ventrolateral processes on the arms, and the small number of segments in P_2; the form and proportions of the lower pinnules also seem to be characteristic.

According to Carpenter the type specimen from the Banda Sea has the centrodorsal thick and discoidal with a small slightly hollowed dorsal pole and very sloping sides, which bear about 25 cirri in an irregular double row. The cirri are XXV, 25. The fourth segment is longer than broad, the next three are the longest, and those following diminish gradually in length. The penultimate segment bears a tolerably strong opposing spine. The radials are barely visible. The IBr_1 are oblong and are not united laterally. The IBr_2 (axillaries) are pentagonal, relatively short, with a wide distal angle; they are only half again as long as the IBr_1. The ventrolateral borders of the IBr axillaries and of the three or four following ossicles bear small irregular tubercles. The IIBr series, IIIBr series, and IVBr series (when present) are 2. The ossicles immediately following each axillary are almost completely united interiorly. The 28 arms are 100 mm. long and consist of nearly 200 brachials. The first brachials are widely rhomboidal. The second brachials are of about the same length, but are more wedge-shaped. The first syzygial pair (composed of brachials 3+4) is nearly square. The next four brachials are oblong, and those following are wedge-shaped and of medium length, with very slightly overlapping distal ends. The later brachials are blunter and more oblong, becoming squarer and slightly elongated at the arm ends. The muscle plates of successive brachials stand up rather prominently, alternately on either side of the ambulacral groove. Syzygies occur between brachials 3+4, again from between brachials 16+17 to between brachials 19+20, and distally at intervals of 4–11 (usually 6–8) muscular articulations.

P_1 is moderately long, but slender, and P_a is shorter than P_1. The pinnules of the next pair (P_2 and P_b) are longer than P_1, and are stiff, tapering, and styliform, consisting of about 15 elongated segments. P_2 is longer than P_b, reaching 15 mm. in length. P_3 is stiff but shorter again, and the following pinnules decrease until about the tenth brachial, after which the size increases slowly. Toward the arm ends the pinnules become slender and filiform, but they never reach the length of the pinnules of the second pair. The disk is 17 mm. in diameter, naked and much incised. Sacculi are closely set along the pinnule ambulacra. The color in alcohol is dorsally light purplish red, with darker bands at the articulations; the perisome is very much darker, almost black.

Hartlaub reexamined the type specimen of *spicata* at Leyden and compared it in detail with his new species *Antedon* (=*Stephanometra*) *oxyacantha*. He said that judging from the type specimen, *spicata* is a much more slenderly built species though otherwise in its general habitus very similar to *oxyacantha*. The postradial series, however, are not widely separated laterally as is the rule in *oxyacantha* but are more nearly in lateral contact. The pinnules of the first pair (P_1 and P_a) are slender and flagellate and reach, as given in Carpenter's latest statement (concerning the specimen from the Mergui Archipelago), almost the length of the pinnules of the following pair (P_2 and P_b), while in *oxyacantha* they are usually markedly shorter than the pinnules of the second pair. P_2 is composed of 16 and more segments and is less markedly spiny than P_2 in *oxyacantha*, which is composed of 12, or at the most 15, segments. P_3 is markedly shorter than P_2 and, as is shown in Carpenter's figure, is less procumbent and stiff, while in *oxyacantha* occasionally it is longer than P_2 and is quite as markedly spiniform. In *spicata* the outer pinnules are slender and filiform, a feature that Hartlaub considered as very characteristic of that form.

I examined this specimen at Leyden in 1910. The cirri are XXIII, 22–25, rather slender, resembling those of such species as *S. protectus*. The longest cirrus segment is about twice as long as the median width, and the longer proximal segments are somewhat constricted centrally, or "dice-box shaped." The IIIBr series are externally developed. The lateral tubercles on the rays are well developed and thick. P_2 is the largest pinnule and is composed of 16 or 17 segments. P_3 is similar but is not quite so long. P_4 is much shorter than P_3, but stiff, with 11 or 12 segments. P_5 is slightly shorter than P_4 and resembles the succeeding pinnules instead of being stiff like those preceding, though it may be a trifle stiffer than its successors.

The specimen from Cocos Island has 30 arms.

A magnificent specimen from Singapore has exactly 20 arms 95 mm. long and the cirri XXV, 24, 20 mm. long. P_2 is 11 mm. long with 18 segments, stiff and spinelike; the terminal 4–6 segments are abruptly less in diameter than those immediately preceding, giving the pinnule tip the appearance of having been broken off and subsequently repaired as described by Carpenter in *Antedon marginata*, and also noticed by Chadwick in a specimen from Ceylon. P_3 resembles P_2, but is only 8 mm. long and is proportionately less stout. The following pinnules are small and weak.

A very fine specimen from Singapore has 31 arms about 150 mm. long. The cirri are XXVII, 26, 28 mm. long. The dorsal pole of the centrodorsal is 3.5 mm. in diameter and is slightly concave. P_2 is 12 mm. long and is composed of 11 segments.

A third specimen from Singapore has the centrodorsal small and discoidal with the dorsal pole slightly concave, 2.5 mm. in diameter. The cirri are XXVIII, 20–23, from 15 to 20 mm. long, and slender. The first segment is short, and those following gradually increase in length to the sixth, which, with the three or four following, is twice as long as broad. The succeeding segments gradually decrease in length so that those in the outer third of the cirri are about as long as broad. The shorter distal segments are faintly carinate dorsally. The opposing spine is prominent, and is subterminal in position. P_1 is 11 to 14 mm. long, with 22–27 segments, equal in length to P_2 and stiff, but much more slender. P_2 has 12–13 segments, of which the distal are about three times as long as broad. P_3 is stiff like P_2, but smaller, 6 to 8 mm. long, with 12 segments. P_4 and the following pinnules are small and weak.

Another specimen with 31 arms resembles the preceding. P_2 is 14 mm. long and is composed of 14 segments.

A fifth specimen from Singapore has 30 arms 100 mm. long. The cirri are XXX, 21–23, from 17 to 20 mm. long. The dorsal pole of the centrodorsal is slightly concave, 2.5 mm. in diameter.

A smaller specimen from Singapore has 14 arms 85 mm. long. On one of the arms arising from a IBr axillary P_3 is exactly like P_2, though usually it is more nearly like P_4. In arms arising from IIBr axillaries the relationships of the lower pinnules are the same as in fully grown individuals.

The specimen from Pulau Obin, Singapore, has 30 arms.

The specimen from Blakang Mati is a fine example of the species. It has 28 arms 125 mm. long. P_2 is 19 mm. long, with 17 segments, and P_3 is 14 mm. long, with 15 segments.

Carpenter said that a single individual that he considered as representing *spicata* was taken at King Island in the Mergui Archipelago. But it has rather more cirri than the type specimen at Leyden and in this respect approaches the allied species *indica* (= *protectus*) and *tuberculata*, which resemble it in having long and stiff pinnules on the fifth and sixth brachials. In *indica,* however, P_1 is much smaller than P_2, as is well shown in Smith's figure, while in *spicata* it may nearly equal its successor in length, though it is far more slender. In *tuberculata* it is also short, though stiffer than in the other two forms.

Carpenter said that *tuberculata* approaches *spicata* in the character of P_3, which is composed of elongated segments like those of P_2 and not of numerous smaller segments as in *indica.* In some arms of *spicata* P_3 is smaller on the outer than on the inner side of the arm—that is, P_3 is smaller than P_c. But the component segments of these large and stiff pinnules have not the extreme length that they reach in *tuberculata.* He remarked that the characters of this Mergui example of *spicata* confirm his separation of this species from *tuberculata,* for the latter has but 12 segments in a P_2 that reaches 15 mm. in length, while in *spicata* a pinnule of the same length consists of 16 segments or more. In both alike, however, the division series have marginal projections that seem to be absent in *indica.* But the cirri of *tuberculata* are stouter though with a somewhat smaller number of segments than occur in *spicata.* The type specimen of *spicata* has no IVBr axillaries, but one occurs in the Mergui specimen.

The specimen recorded by Chadwick from Ceylon at station XXXIX was considerably mutilated. It had 11 arms. In most cases P_2 agreed well with P_2 in the type specimen of *marginata,* seeming to have been broken off by some accident and incompletely repaired.

Chadwick said that a small specimen from Welligam Bay (station XXXIV) may possibly belong to this species (*marginata*). The number of arms can not be determined, but in one of the postradial series the outer face of the IIBr axillary bears two IIIBr series.

The specimen from *Mabahiss* station 10 has 20 arms 105 mm. long. The two cirri remaining have 18 and 20 segments; the longest is 16 mm. long. P_3 may resemble P_2 and be of the same size, though usually it is smaller, or it may be more or less reduced and weak, resembling, or approximating in appearance, P_4. P_2 is composed of 17 segments and is slender and delicate distally instead of stout and spinelike as usual. This specimen is more or less intermediate between *spicata* and *indica,* though more like the former.

One of the specimens without locality (Berl. M., 5287) is large with 33 arms 100 mm. long. The cirri are XXXV, 18–25 (usually the latter), 15 to 25 mm. long, the peripheral cirri being the longest. The first two segments are very short, and those following gradually increase in length so that the fourth or fifth is about as long as broad. Those succeeding are about as long as broad or slightly longer than broad, after the middle of the cirrus gradually becoming shorter so that the segments in the outer third are slightly broader than long. The short distal segments are strongly compressed laterally and bear a faint median dorsal carination. There are no dorsal spines. The opposing spine is prominent, subterminal, and directed obliquely forward. The terminal claw is slightly longer than the penultimate segment and is stout and rather strongly curved. The sides of the ossicles of the division series are ventrolaterally produced into prominent flangelike borders, which, however, are comparatively narrow. P_1 is 10 mm. long, slender, and flagellate, composed of 20 segments, of which the first is twice as broad as long, the third is about as long as broad, and those following gradually increase in length so that the distal are three times as long as broad. P_2 is stout and very stiff, 13.5 mm. long, with 14 segments, of which the first is twice as broad as long, the third is somewhat longer than broad, the fourth is half again as long as broad, the fifth is twice as long as broad, and the remainder are nearly three times as long as broad. P_3 is 9 mm. long with 10 segments and is similar to P_2, but the segments are relatively more elongated. P_4 is small, slender, and weak, 4.5 mm. long, with 11 segments.

The other specimen without locality (Berl. M., 5288) has 28 arms about 100 mm. long. The centrodorsal is low hemispherical, about 5 mm. in diameter at the base, with the approximately flat dorsal pole 1.5 mm. in diameter and studded with small deep pits representing obsolete cirrus sockets. The cirri are XXVII, 21–22, from 20 to 25 mm. long, and are arranged on the centrodorsal in two and a partial third closely crowded alternating marginal rows. The longer proximal cirrus segments are half again as long as their proximal width and have a slightly concave ventral profile so that their ends are prominent. The outermost 10 segments are about as long as broad, and the distal, especially the last three or four, are rather strongly carinate dorsally. The opposing spine is prominent and subterminal. The terminal claw is stout, rather short, and strongly curved. All but one of the postradial series bear external IIIBr series. The exception is a postradial series with the IIBr and IIIBr series missing on one side. P_1 is slender and flagellate, 7 mm. long, with about 17 segments. P_2 is stiff and spinelike, 12 mm. long, with 11 segments. P_3 is 10.5 to 11 mm. long, with 10 segments, very slightly slenderer than P_2. P_4 is 7.5 to 8 mm. long, with 9 or 10 segments, much smaller than P_3 though more or less like it distally. P_5 is 4.5 to 5 mm. long, with 10 segments, and is slender and weak. The following pinnules are short and soft with short segments.

Localities.—Macclesfield Bank; 36–64 meters [Bell, 1894; A. H. Clark, 1912, 1913] (1, B.M.).

Nha'trang, Annam; littoral; Dr. C. Dawydoff [Gislén, 1936].

Bantayan reef, Cebu, Philippines; Lawrence E. Griffin (2+, M.C.Z., 387, 396 [original Nos. 68, 99]).

Siboga station 99; anchorage off North Ubian (lat. 6°07′30″ N., long. 120°26′00″ E.); 16–23 meters; lithothamnion bottom; June 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Pelew Islands [A. H. Clark, 1912] (1, H.M.).

Ruk, Caroline Islands [A. H. Clark, 1912] (1, H.M.).

New Guinea [A. H. Clark, 1912; Hartmeyer, 1916] (1, Berl. M., 2971 [5347]).

Pitilu, Admiralty Islands; Dr. G. Duncker [A. H. Clark, 1912] (1, H. M.).

Ugi, Solomon Islands [Bell, 1885; A. H. Clark, 1912].

Challenger station 174 (B, C, or D); near Kandavu, Fiji (lat. about 19°06′ S., long. about 178°18′ E.); 411, 1,115, or 383 meters; coral mud; bottom temperature, at 1,115 meters, 39° F.; August 3, 1874. The specimen could not have come from any of the depths given, but was probably taken in shore collecting. [von Graff, 1887; P. H. Carpenter, 1888, 1889; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1912, 1913] (1, B.M.).

Lifu, Loyalty Islands [Bell, 1899; A. H. Clark, 1912, 1913] (2, B. M.).

New Caledonia; M. François, 1894 [A. H. Clark, 1911] (1, P. M.).

Mer, Murray Islands, Torres Strait; among corals on the southwestern reef; H. L. Clark, October 14, 1913 [H. L. Clark, 1915, 1921; A. H. Clark, 1918] (1, M. C. Z., 600).

Banda Sea; Semmelink, 1881 [P. H. Carpenter, 1881, 1883, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1918] (1, L. M.).

Cocos Island (in the Indian Ocean south of Sumatra); Doctor Wood-Jones [A. H. Clark, 1912, 1913] (1, B. M.).

Singapore; Svend Gad [A. H. Clark, 1909, 1912] (1, C. M.). Same (4, C. M.).

Pulau Ubin, Singapore [A. H. Clark, 1912, 1913] (1, B. M.).

Blakang Mati, near Singapore; 1899 [A. H. Clark, 1934] (1, Raffles Mus.).

King Island, Mergui archipelago; sublittoral [Bell, 1888; P. H. Carpenter, 1889].

Ceylon Pearl Oyster Fisheries station XXXIX; southern coast of Ceylon from 2 miles south of Point de Galle westward to Gallehogalle Bank; 29–55 meters; bottom, fine sand; stones and nullipores on the bank [Chadwick, 1904; A. H. Clark, 1912; H. L. Clark, 1915].

?Ceylon Pearl Oyster Fisheries station XXXIV; southern coast of Ceylon; various parts of Welligam Bay; 4–13 meters; bottom, shell sand and a little mud; temperature at 7 a. m., 77.8° F.; specific gravity 1.0225 [Chadwick, 1904; A. H. Clark, 1912; H. L. Clark, 1915].

Mabahiss station 10; Red Sea (lat. 13°31′00″ N., long. 42°31′00″ E.); 55 meters; September 17, 1933 [A. H. Clark, 1936] (1, B. M.).

No locality [A. H. Clark, 1912] (2, U.S.N.M., 35237 [from Berl. M.]; Berl. M., 5287, 5288).

Geographical range.—From the Macclesfield Bank and the Philippine Islands to the Pelew and Caroline Islands, New Guinea, the Admiralty and Solomon Islands, Fiji, the Loyalty Islands, and Torres Strait, westward to the Red Sea.

Bathymetrical range.—From the shore line down to 55 (?64) meters. Most of the specimens have been taken in shore collecting.

History.—This species was first described as *Antedon spicata* by Dr. P. H. Carpenter in 1881 from a specimen in the Leyden Museum that had been collected by Semmelink in the Banda Sea. In October 1882, Prof. Jeffrey Bell published a specific formula for this form, which was emended by Carpenter in April, 1883.

In 1885 Professor Bell recorded it from Ugi (or Ughi) in the Solomon Islands, and in 1888 he said that it had been collected by Dr. John Anderson in the Mergui Archipelago.

In the *Challenger* report on the myzostomes published in 1887 Prof. Ludwig von Graff mentioned *Antedon tuberculata* from station 174 as a host for myzostomes. The name, supplied by Carpenter, appears as a *nomen nudum.*

In the *Challenger* report on the comatulids published in 1888 Carpenter described *Antedon tuberculata* as a new species. He said it has many points of resemblance with *spicata*, and he suspected that it might prove to be a synonym of the latter.

Carpenter did not discuss *spicata* in detail in the *Challenger* report, as it was not taken by the expedition, but he inserted it in the key to the species of the *Palmata* group, including it with *tuberculata* and *indica* in a special section set apart by the possession of IIBr and IIIBr series, and sometimes additional division series, by having the division series free laterally, and by having P_2 stiff and styliform, with 12–18 much elongated segments. He included *tuberculata* and *spicata* in a group characterized by postradial series with marginal projections and by having P_3 not greatly shorter than P_2; *indica*, with which *tuberculata* and *spicata* were contrasted, was said to have the margins of the postradial series smooth and P_3 considerably shorter than P_2. Later in the text he said that *indica* differs from *spicata* and *tuberculata* in the slighter development of marginal processes at the bases of the rays. The difference between *tuberculata* and *spicata* was said to be that *tuberculata* has XL cirri and the the IBr_2 (axillaries) more than twice as long as the IBr_1, while in *spicata* there are XXV cirri and the IBr_2 (axillaries) are less than half again as long as the IBr_1. Carpenter included *marginata* with *clemens* (=*Heterometra quinduplicava*) in a special section of the *Palmata* group characterized by the possession of IIBr series, but no further division, and therefore in the key did not compare it directly with *spicata* or *tuberculata*.

In 1889 Carpenter recorded and gave notes upon a single specimen from King Island in the Mergui Archipelago and referred it to *spicata*. He again compared *spicata* with *tuberculata* and *indica* and said that in the latter marginal projections seem to be absent from the sides of the division series. In this case he seems to have interpreted *indica* wholly on the basis of Smith's figure, as he did when preparing the key to the species of the *Palmata* group in the *Challenger* report; but in other cases his references to *indica* indicate that he considered as belonging to that species the form herein described as *Stephanometra protectus* (see p. 443).

In his key to the species of the *Palmata* group published in 1891 Dr. Clemens Hartlaub placed *spicata*, *tuberculata*, and *indica* among the species characterized by the possession of IIIBr and sometimes additional division series. The two first are included in a section characterized by the possession of marginal processes on the elements of the division series, while *indica* was said to have no marginal processes on the division series, 30 arms, and P_2 with more than 12 segments. He grouped *spicata* and *tuberculata* in a division characterized by having P_3 of the same character as P_2 and only slightly or not at all smaller, contrasting them with *monacantha* (=*protectus*) in which P_3 is much shorter than P_2 and is not stiff and styliform; *spicata* he said has P_2 with 16–20 segments and the outer pinnules long and filiform, while in *tuberculata* P_2 has less than 16—usually about 12—very long segments. Hartlaub had examined the type specimen of *spicata* at Leyden, and also a specimen that he identified as *tuberculata*—evidently the one from Ruk, as that is the only one of the three in the Hamburg Museum in which P_4 resembles the succeeding pinnules more than it does P_3—and compared the forms in considerable detail.

In my first revision of the old genus *Antedon* published in 1907 *spicata* and *tuberculata* were referred to the genus *Himerometra*, from which they were removed to the new genus *Stephanometra* in 1909. Later in 1909 I recorded *Stephanometra marginata* from Singapore, my records and notes being based upon a misidentified specimen of this species.

In 1911 I published a redescription of the type specimen of *Antedon spicata*, which I had examined in the Leyden Museum the previous year, and in another paper I recorded, as *Stephanometra* sp., a specimen from New Caledonia.

In a paper on the crinoids of the Hamburg Museum published in 1912 I recorded and gave notes on specimens of *Stephanometra tuberculata* from Ruk, Pitilu, and the Pelew Islands.

In a paper on the crinoids of the Berlin Museum published in 1912 I recorded a specimen of *Stephanometra tuberculata* from New Guinea and two without locality, giving notes on all three.

In my monograph on the crinoids of the Indian Ocean published in 1912 I recognized *Stephanometra spicata* and *S. tuberculata.* The type specimen of *spicata* was redescribed.

In a paper on the crinoids in the British Museum published in 1913 notes on the type specimen of *tuberculata* were given, and also on the specimen of *Antedon ?spicata* from the Macclesfield Bank and of *Antedon tuberculata* from Lifu recorded by Bell. Other specimens were recorded from Pulau Obin, Singapore, and from Cocos Island.

In 1915 Dr. H. L. Clark described *Stephanometra stypacantha* from Mer Island, Torres Strait.

In the report on the unstalked crinoids collected by the *Siboga* published in 1918 I placed *tuberculata, stypacantha,* and (erroneously) *marginata* as synonyms under *spicata.* I recorded and gave notes on a specimen from station 99.

In 1924 Dr. Torsten Gislén gave a detailed account of the structure of *Stephanometra spicata,* supplementing this in 1934, and in the latter year the author recorded a specimen from Blakang Mati, near Singapore.

In 1936 Dr. Gislén recorded and gave notes upon a specimen from Annam.

STEPHANOMETRA INDICA INDICA (Smith)

PLATE 51, FIGURES 233, 234; PLATE 91, FIGURES 449, 450

Comatula indica SMITH, Ann. Mag. Nat. Hist., ser. 4, vol. 17, 1876, p. 406 (description; Rodriguez).—SMITH, Phil. Trans. Roy. Soc., vol. 168, 1879, p. 564 (description; Rodriguez), pl. 51, figs. 3, 3*b* [but not fig. 3*a*] —A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 3 (history); Crinoids of the Indian Ocean, 1912, p. 3 (same).

Antedon indica P. H. CARPENTER, Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 35, 54, 210, 225, 232, 233, 366, 379; Journ. Linn. Soc. (Zool.), vol. 21, 1889, pp. 310, 311 (comparison with *A. spicata*).—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 39 (in key), p. 58 (in second section of species of the *Palmata* group with spiny lower pinnules).—CHADWICK, *in* Herdman, Report Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon), p. 154 (Sta. LIV).—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, pp. 34, 39, 40 (identity of previous records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 83 (of Bell, 1899=*Lamprometra protectus* [i. e., *palmata*]; of Bell, 1902=*Comaster gracilis*).

Antedon marginata CHADWICK, Journ. Linn. Soc. (Zool.), vol. 31, 1908, p. 45 (Suez Bay, 10 fathoms; characters of the specimens).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 5 (identity of Chadwick's Red Sea record); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, 1937, p. 89 (identity).

Antedon palmata BELL, Trans. Linn. Soc. (Zool.), ser. 2, vol. 13, pt. 1, 1909, p. 20 (Farquhar Atoll, North reef).—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, 1937, p. 89 (identity).

Antedon spicata BELL, Trans. Linn. Soc. (Zool.), ser. 2, vol. 13, pt. 1, 1909, p. 20 (Seychelles, 39 fathoms).

Antedon monacantha Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 179 (in part; specimen from Torres Strait); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 61 (specimen from Torres Strait; comparisons), pl. 3, fig. 33; Mem. Mus. Comp. Zool., vol. 27, 1912, p. 412 (specimen from Torres Strait).

Himerometra indica A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra monocantha A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (in part; listed).

Stephanometra indica A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (listed); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 6 (*Antedon palmata* recorded by Bell from southeast Africa is this species), p. 8 (occurs on the southeast coast of Africa), p. 13 (common to southeast Africa and Ceylon), p. 26 (synonymy; localities; description of a specimen; comparisons); Bull. Mus. Hist. Nat., Paris, 1911, p. 252 (Madagascar; description); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 21 (discussion of Hartlaub's specimen from Torres Strait); Crinoids of the Indian Ocean, 1912, p. 3 (history), p. 11 (represented in the Ceylon region), pp. 34, 40, 41 (identity of previous records), p. 135 (synonymy; summary of records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 29 (published references to specimens in the British Museum; Rodriguez; Seychelles [specimens from Tuticorin and the Maldives are *protectus*]); Unstalked crinoids of the *Siboga*-Exped., 1918, p. IX (range), p. 94 (in key; range), p. 97 (synonymy; notes; Torres Strait and Madagascar [specimens from station 301, Ceylon, and Mer are *protectus*]).—H. L. Clark, Spolia Zeylanica, vol. 10, part 37, 1915, p. 93 (occurs at Ceylon).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 20.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 87 (listed), p. 88 (*Mabahiss* stations 10, M. B. I. *d.*; notes; range; comparison with *protectus*), p. 104.

Stephanometra monacantha A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 10 (in part; listed); Vid. Medd. Naturh. Foren. København, 1909, p. 169 (specimen from Torres Strait); Mem. Australian Mus., vol. 4, pt. 15, 1911, pp. 718, 769 (record from Torres Strait); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, pp. 440, 443 (record from Torres Strait); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, pp. 223 ff. (record from Torres Strait); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 21 (Hartlaub's specimen from Torres Strait appears to be nearer *indica* than *monacantha* [=*protectus*]).

Lamprometra callipecha H. L. Clark, Carnegie Inst. Washington Publ. 212, 1915, p. 104 (description; Mer).—A. H. Clark, Unstalked crinoids of the *Siboga* Exped., 1918, p. 100, footnote 1 (in synonymy of *Lamprometra protectus* [=*palmata*]).

Stephanometra callipecha H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 8 (collected by the Carnegie Exped., 1913), p. 21 (Mer; possibly is *S. indica;* notes), pp. 192 ff. (range), pl. 1, fig. 9 (colored), pl. 36, figs. 2, *a–e*.

[*Stephanometra*] *callipech* H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 22, footnote 1 (typographical error).

Stephanometra indica indica A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 88 (comparison with *S. i. protectus*), p. 100 (range).

Diagnostic features.—The outer cirrus segments are wholly without dorsal processes, being merely more or less sharply carinate in the middorsal line; P_1 is flexible, flagellate, delicate, and slender, much smaller and weaker than P_2; P_2 is very long, much longer than is *S. protectus*, enlarged, though not excessively so, stiffened, distally gradually tapering to a fine stiff point, and recurved, and is composed of 16–20 (usually 17–20) segments, of which the fourth and fifth are not abruptly longer than the others; P_3 is small, flexible, and weak, like the pinnules following; there are 18–30 arms 65–153 mm. long; and the cirri have 22–25 segments.

Description.—The centrodorsal is small, flat or convex, more or less subpentagonal, less than 5 mm. in diameter, with the bare dorsal pole about 3 mm. across. The cirrus sockets are arranged in from two to three crowded alternating marginal rows.

The cirri are XXI–XLV, 22–25, about 12 mm. long. The first three segments are about as long as broad or slightly broader than long, the fourth-eighth are longer than broad, the longest, the fifth or sixth, being about half again as long as broad, and those following are broader than long. The longer proximal cirrus segments are slightly constricted centrally. The distal portion of the cirri is laterally compressed, and the distal segments bear a low dorsal median keel. There are no dorsal processes. The opposing spine is well developed.

The radials and division series resemble those of *S. i. protectus* (page 443); the IIIBr series are normally externally developed, but in one specimen examined they are internal. The ossicles of the division series and first two brachials have more or less developed ventrolateral processes.

The 18–30 arms are 65–153 mm. long. The smooth and short brachials are at first practically oblong, then becoming obliquely wedge-shaped, almost triangular, and after about the thirtieth oblong again, and terminally longer than broad.

Syzygies occur between brachials 3+4, from between brachials 14+15 to between brachials 18+19, and distally at intervals of 6–11 muscular articulations. Sometimes there is an additional syzygy between brachials 9+10.

P_1 is about 6 mm. long, with about 20 segments, and resembles P_1 in *S. i. protectus*. P_a is much smaller than P_1, with about 11 segments. P_2 is long, stiff, and spinelike, becoming slender distally, 7–17 mm. long, with 16–20 segments. The first two segments are short and those following are elongate, those in the middle of the pinnule being the longest. P_3 is small and weak, the smallest pinnule, with about 10 segments. The pinnules following gradually increase in length, those in the middle of the arm being 6–7 mm. long, with about 20 segments.

Notes.—The material from *Mabahiss* station 10 consists of arm fragments and a detached disk representing two individuals.

The specimen from motorboat station I*d* has 20 arms; the cirri have 17 or 18 segments; P_2 is 7 mm. long with 14–16 segments and becomes slender and delicate terminally; on one arm P_3 resembles P_2.

Two small and imperfect specimens from Suez Bay were referred to *marginata* by Chadwick with some little doubt. He said that as in the type specimen the centrodorsal is a saucer-shaped disk marked with cirrus sockets almost to the center of the dorsal surface and bears the cirri in an irregular row around its margin. The cirri are XVII, 15–17 or even 19, the segments gradually increasing in length from the first to the seventh, beyond which they are scarcely longer than broad and become increasingly compressed, and are slightly carinate dorsally or even bear a minute dorsal spine. The radials are distinctly visible and are not in contact except at their proximal ends. In the type of *marginata* they are only just visible, but this point of difference, Chadwick said, is possibly due to the immature condition of the Suez specimens. The IBr series agree with those of the type. In one of the specimens only IBr series are present. In the other there are two IIBr ossicles on one branch of each postradial series, and in the case of one postradial series two IIIBr ossicles. Syzygies occur between brachials 3+4, 9+10, and 16+17, and distally at intervals of five or six muscular articulations. The proximal pinnules have fewer segments than those of the type of *marginata*. P_1 has 14 segments, and P_2 has 14 or 15. P_b is little larger than P_1, but has 15 or 16 segments, while P_c has 11 or 12 segments and is much smaller than P_1.

The specimen from the Seychelles is small.

In the specimen from Madagascar the cirri are XXX, about 22, and smooth like those of *S. i. protectus.* The sixth segment is the longest, half again as long as broad. The longest cirrus segments are slightly constricted centrally. There are about 25 arms. The IIIBr series are in all cases developed internally instead of externally as is usual in the species of *Stephanometra.* P_2 is long, stiff, and spinelike, with about 16 segments. P_3 is small and feeble.

Dr. E. A. Smith described *Antedon indica* from Rodriguez in 1879 as follows:

> Rays 30; dorsal disk, small, convex, subpentagonal, sculptured with little contiguous and well-defined pits which are the sockets of the cirri; these are about 45 in number; radial joints two, the axillary without a syzygium; between this and the next bifurcation are two articulations; after two more joints the two outermost arms bifurcate; none of the brachial axillaries with a syzygium; each third segment above an axillary has a syzygium, and on the arms the next joints with syzygies are at very unequal distances, the most proximate being separated by as many as 20 joints, but usually by about 14; then nearer the extremity of the rays, they are rather closer together, the interlying joints varying in number from 6 to 10.
>
> The second pinnulae are very long and composed of much elongated joints. The colour of the specimen is pale purplish brown, with the sutures of the ray-articulations blackish brown. Diameter of disk 6 mill., length of rays about 6 inches (153 millim.) * * *
>
> The remarkably elongate second pinnulae (17 mill. in length) are situated on the first and second segments above those joints which always have a syzygium, and which are the third joints above the last brachial axillaries, or in other words, they rest upon the fourth and fifth joints above these axillaries. They consist of about 17 joints, which are elongate, cylindrical, those at the middle being the longest, and the two or three basal ones the shortest.

Dr. Smith called attention to the fact that in the preliminary description published in 1876 he had, by an oversight, stated that the two innermost arms following the first axillaries bifurcate; it should have read outermost or exterior—that is, the IIIBr series are developed externally, not internally. He figured a cirrus that was found among debris at the bottom of the bottle containing the specimen, but he said it is not absolutely certain that it belongs to the species described, although the evidence points to that conclusion. The cirrus he figured belongs not to *S. indica* but to some species of the family Comasteridae. I examined this specimen at the British Museum in 1910. It is best described as resembling a specimen of *S. protectus,* but with P_2 longer and composed of more numerous segments; though slender distally, P_2 is not flagellate.

The specimen recorded by Chadwick from Ceylon had 29 arms. The original visceral mass was almost completely displaced but remained in organic continuity with a new one in an early stage of formation.

Dr. Hubert Lyman Clark described *Lamprometra callipecha* from Mer Island, Torres Strait, in the following terms: The centrodorsal is rather small, flat, less than 5 mm. in diameter, with the bare dorsal pole 3 mm. across. The cirri are XXXI, 23–25, about 12 mm. long. The first-third segments are short and thick, the fourth-eighth are longer than broad, and those following are broader than long. The cirri are laterally compressed distally, and the distal segments have low and minute longitudinal dorsal ridges. The opposing spine is well marked. The 18 arms are about 65 mm. long by 10(?) mm. broad. There are four IIBr and four IIIBr series present, all 2. The IIBr series are not appressed; the ossicles of the division series have slight lateral expansions. The brachials are smooth, not overlapping, wedge-shaped, becoming quadrate after the thirtieth, and at the tip of the arm longer than broad. Syzygies occur between brachials 3+4, 9+10, 14+15, 18+19, and 23+24, and then at intervals of 8 to 11 muscular articulations. All the pinnules are cylindrical, and the lower ones are stiff and little flagellate. P_1 is about 6 mm. long and consists of 19 segments. P_a is much smaller, little longer than P_3, and consists of 11 segments. P_2 is the largest pinnule, 7 or 8 mm. long, and consists of 18 segments. P_b is longer than P_a, and consists of 11 segments. P_3 is the smallest pinnule and consists of 10 segments. P_c is very similar to P_3. The succeeding pinnules gradually increase in length until at the middle of the arm they are 6 or 7 mm. long, with about 20 segments. The color is rich purple, with the base of the arms and a broad distal band white, the pinnules often with yellowish or rusty tips. The cirri are cream color dorsally and deep brown on the ventral side. Dr. Clark said that the colors were almost perfectly preserved in alcohol.

The specimen from Torres Strait included in the material from which Hartlaub described *Antedon monacantha* has about 20 arms. The second syzygy is between brachials 16+17 or 17+18, and the distal intersyzygial interval is six or seven muscular articulations. While in the specimens from Mortlock Island (=*protectus*) P_2 is very stout and strong and is composed of only 12 segments, in the present specimen from Torres Strait it is much more slender, with about 20 segments, of which the fourth and fifth are not set off from those succeeding by their greater length.

Habits.—Dr. Hubert Lyman Clark said that the type specimen of *Stephanometra callipecha* proved to be an active individual and was a very graceful swimmer.

Localities.—*Mabahiss* station 10; Red Sea (lat. 13°31′00″ N., long. 42°31′00″ E.); 55 meters; September 17, 1933 [A. H. Clark, 1936] (fragments, B. M.).

John Murray Expedition to the Indian Ocean, 1933–1934, motor boat station *Id;* Red Sea; bay between Great Hanish and Suyul Hanish Islands (lat. 13°39′30″ N., long. 42°43′00″ E.); 26 meters; sand, shells, and coral; September 17, 1933 (1, B. M.).

Suez Bay; 18 meters; mud [Chadwick, 1908; A. H. Clark, 1909, 1911, 1912].

Seychelles; 62 meters [Bell, 1909; A. H. Clark, 1911, 1912, 1913, 1918] (1, B. M.).

Madagascar; M. Grandidier, 1905 [A. H. Clark, 1911, 1912, 1918] (1, P. M.).

Rodriguez; Henry H. Slater, Transit of Venus Expedition, 1874 [Smith, 1876, 1879; P. H. Carpenter, 1883, 1888, 1889; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1913, 1918] (1, B. M.).

Farquhar Atoll, north reef [Bell, 1909; A. H. Clark, 1911].

Ceylon Pearl Oyster Fisheries station LIV; in the northern part of the Gulf of Manaar, south of Adam's Bridge; 7–73 meters; bottom varied, from sand to living coral [Chadwick, 1904; A. H. Clark, 1911, 1912, 1918; H. L. Clark, 1915].

Mer Island, Murray Islands, Torres Strait; southwestern reef; H. L. Clark, October 27, 1913 [H. L. Clark, 1915, 1921; A. H. Clark, 1918] (1, M. C. Z., 592).

Torres Strait [Hartlaub, 1890, 1891; A. H. Clark, 1909, 1911, 1912, 1918].

Geographical range.—From Madagascar, the Seychelles, and the Red Sea to Ceylon; Torres Strait.

Bathymetrical range.—Littoral and down to 62 (?73) meters; most of the records are from the shore line.

History.—This species was originally described in 1876 under the name of *Comatula indica* from a single specimen collected at Rodriguez by Henry H. Slater while on the Transit of Venus expedition in 1874. It was redescribed in practically the same terms and figured by Dr. Smith in 1879.

Dr. P. H. Carpenter published a specific formula for *Antedon indica* in 1883, and in the *Challenger* report on the comatulids published in 1888 he mentioned it several times, though he added no new information in regard to it. In the key to the species of the *Palmata* group he gave as the chief distinguishing characters: "Margins of rays smooth; third pinnule considerably shorter than the second," contrasting it with *tuberculata* and *spicata* in which the "rays have marginal projections; third pinnule not greatly shorter than the second." In 1889 Carpenter compared *indica* in some detail with *spicata*.

In 1890 Dr. Clemens Hartlaub described *Antedon monacantha* (=*protectus*), which was based on two specimens from Mortlock Island and one from Torres Strait. In 1891 Hartlaub redescribed and figured this new species, his figure of the proximal pinnules being drawn from one of the two specimens from Mortlock Island and his figure of the centrodorsal and arm bases being drawn from the specimen from Torres Strait. This last specimen Hartlaub had received for examination from Dr. P. H. Carpenter, but he said nothing further regarding its origin.

In 1904 Herbert Clifton Chadwick recorded a specimen of *Antedon indica* from Ceylon. There is a possibility that this specimen in reality represents *S. protectus*.

In my first revision of the old genus *Antedon* published in 1907 *indica* was assigned to the new genus *Himerometra*, and in my revision of the family Himerometridae published in 1909 it was transferred to the new genus *Stephanometra*.

In 1908 Chadwick recorded and gave notes on two specimens from Suez Bay, which he recorded under the name of *Antedon marginata*.

In 1909 Prof. F. Jeffrey Bell recorded *Antedon palmata* from Farquhar Atoll, and *A. spicata* from the Seychelles in 39 fathoms. There is a specimen of *S. indica* from the Seychelles in 34 fathoms in the British Museum on which apparently the latter record was based, at least in part. I have a note that Bell's *A. palmata* is the same species, but no record of having seen the specimen or specimens. Regarding *A. spicata* Professor Bell said that he was in some doubt as to the correctness of the identification. He noted that P. H. Carpenter described this species in 1881 from, it would seem, a single specimen, and that no subsequent writer that he knew of had ever mentioned it.

In a discussion of *Stephanometra monacantha* (=*protectus*) published in 1909 in a paper on the crinoids of the Copenhagen Museum, I said that the specimen therein described from the Nicobar Islands (see page 452) agrees more nearly with Hartlaub's specimen from the Caroline Islands (=*protectus*) than with the one from Torres Strait (=*indica*).

In a paper on the crinoids of the Paris Museum published in 1911 I recorded and gave notes on a specimen of *S. indica* from Madagascar.

In a paper on the crinoids of Africa published in 1911 I republished in English my notes on the specimen from Madagascar and gave as the localities from which this species is known Rodriguez, Madagascar, the Seychelles, and Farquhar Atoll. I said that the species has also been reported from Ceylon, the Maldive Islands, and the

Bay of Bengal. These last records, however, except one from Ceylon, refer to *protectus.*

In a memoir on the recent crinoids of Australia published in 1911, and in another paper on the crinoids of southwestern Australia published in the same year, I referred Hartlaub's specimen from Torres Strait to *S. monacantha* (=*protectus*).

In 1912 Hartlaub compared a specimen of *Antedon monacantha* (=*S. protectus*) from the Marshall Islands with his original specimens from Mortlock Island and Torres Strait.

In a paper on the crinoids of the Hamburg Museum published in 1912 I said that the specimen recorded by Hartlaub from Torres Strait appears to be nearer *S. indica* than *S. monacantha* (=*protectus*).

In my memoir on the crinoids of the Indian Ocean published in 1912 I gave a synonymy of *S. indica* and a list of the localities from which the species is known. The synonymy includes some references that should have been placed under *S. monacantha* (=*protectus*). Of the localities given, Madagascar, the Seychelles, Rodriguez, Farquhar Atoll, and Ceylon (in part) refer to *S. indica,* and Mublas (=Muhlos), Male, Hulule, and Muhlos, Maldives, Ceylon (in part), and Tuticorin refer to *S. protectus.* In a short paper on a small collection of recent crinoids from the Indian Ocean published at Calcutta in the same year *S. indica* was recorded from latitude 8°51′30″ N., longitude 81°11′52″ E., in 28 fathoms; the two specimens on which this record was based are in reality *S. protectus.*

In a paper on the crinoids of the British Museum published in 1913 I noted that I had examined Smith's type specimen of *Comatula indica,* and also another specimen from the Seychelles taken in 34 fathoms. I also recorded as *S. indica* a number of specimens from the Maldives and Tuticorin, which represent in reality *S. protectus.*

In 1915 Dr. Hubert Lyman Clark described a new species, *Lamprometra callipecha,* which was based upon a specimen that he had personally collected at Mer Island in Torres Strait in 1913, and in another paper he included *S. indica* in a list of the crinoids of Ceylon.

In a paper on the distribution of the recent crinoids on the coast of Australia published in 1915, I included Hartlaub's specimen from Torres Strait under *S. monacantha* (=*protectus*).

In my report upon the unstalked crinoids of the *Siboga* expedition published in 1918 I gave a synonymy of *S. indica* and recorded and described a specimen from station 301 that is in reality *S. protectus.* I said that this specimen appears to be identical with Hartlaub's specimen of *monacantha* from Torres Strait; it also agrees with specimens of *indica* (=*protectus*) at hand from Ceylon and with others from Madagascar, though the size is somewhat greater. I added that there can be little doubt that the specimen taken by Dr. H. L. Clark at Mer Island, Torres Strait, and recorded by him as *S. monacantha* belongs to this species. In the key to the species of the genus *Stephanometra, monacantha* (=*protectus*) was given as having P_2 much enlarged and stiffened, usually more or less straight, ending distally somewhat abruptly in a stout point, and composed of 11–15 (usually 12) segments of which the fourth-fifth are markedly the longest; *indica* was given as having P_2 somewhat less enlarged and stiffened, usually more or less strongly recurved, becoming very slender and delicate distally, though not flagellate, and composed of 15–20 segments of which the fourth-fifth are not especially noticeable. The range of *monacantha* was given as from the Andaman Islands to Singapore, the Philippines, the Malay Archipelago, New Caledonia, Fiji, and the Tonga and Caroline Islands; the range of *indica* was said to be from Madagascar, the Seychelles, and Rodriguez to Ceylon and southern India, also the Lesser Sunda Islands and northern Australia. Dr. H. L. Clark's *Lamprometra callipecha* was placed in the synonymy of *Lamprometra protectus* (=*palmata*).

In his memoir on the echinoderms of Torres Strait published in 1921 Dr. H. L. Clark noted that I had referred the specimen from Mer that he had recorded as *monacantha* to *indica*, but since examining the specimen I had become satisfied that it really is *monacantha* (=*protectus*). Under *Stephanometra callipecha* he said that the reexamination of the type specimen of this species, resulting from my assigning it to the synonymy of *Lamprometra protecta* (=*palmata*), had led him to believe that it should be regarded as a *Stephanometra* rather than as a *Lamprometra*, and that it is possibly identical with *S. indica*. He added that after examining the type specimen I had decided that it is *indica*.

STEPHANOMETRA INDICA PROTECTUS (Lütken)

Plate 49, Figure 222; Plate 50, Figures 225–230; Plate 51, Figures 231, 232

[See also vol. 1, pt. 1, fig. 6 (proximal pinnules), p. 63; fig. 314 (cirrus tip), p. 273; fig. 340 (cirrus), p. 287; pt. 2, fig. 130 (arm base), p. 79; fig. 310 (proximal pinnules), p. 223; figs. 469–471 (pinnule tips), p. 266; fig. 726 (disk), p. 346.]

Antedon protectus Lütken, Mus. Godeffroy Cat., vol. 5, 1874, p. 190 (Tonga Islands; *nomen nudum*); in P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 19 (character of the oral pinnules).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641 (identity).

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Antedon marginata von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, p. 12 (station 208; myzostomes)—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 230 (description; Sta. 208), pl. 40.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 37 (in key).—Chadwick, Report Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon), p. 154 (Stas. XXXIX, XXXIV; characters of the specimens).—Minckert, Archiv für Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 199 (syzygies; regeneration).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 34, 40, 41 (identity of previous records).

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Antedon monacantha Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 179 (description; Mortlock Island [specimen from Torres Strait is *S. indica*]); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 39 (in key), p. 58 (in second section of species of the *Palmata* group, with spiny oral pinnules), p. 59 (detailed description; Mortlock Island, only [specimen from Torres Strait is *indica*]; comparisons), pl. 3, fig. 38 (not fig. 33, which represents *indica*), p. 113 (in Göttingen Mus.).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol.2, Abt. 3, 1907, p. 1581 (listed; in part).—A. H. Clark, Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 718 (identity); Smithsonian Misc.Coll., vol. 60, No. 10, 1912, p. 2 (of Hartlaub=*Stephanometra monacantha*, in part), p. 21 (specimen from Torres Strait appears to be nearer *indica* than to the species represented by the one from Mortlock Island); Crinoids of the Indian Ocean, 1912, p. 37 (identity).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 280 (listed), p. 412 (synonymy; Ebon, Marshall Islands; notes; Sunda Straits; notes).—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 89 (identity).

Antedon flavomaculata Bell, Proc. Zool. Soc. London, 1894, p. 396 (Macclesfield Bank, 13 fathoms), p. 400 (description).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 472 (not recognizable; certainly not a member of the *Spinifera* group, in which described; probably belongs to the *Palmata* group, possibly to the *Multicolor* group); Crinoids of the Indian Ocean, 1912, p. 38 (identified as *Stephanometra monacantha);* Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 82 (same).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 309 (in *Spinifera* group; history; discussion), p. 310 (insufficiently described.)—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank).

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Himerometra helianthus A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (*nomen nudum;* listed).

Himerometra monocantha A. H. Clark, Smithsonian Misc. Coll., vol. 50 1907, p. 356 (listed).

Himerometra heliaster A. H. Clark, Bull. Mus. Comp. Zool., vol. 51, 1908, p. 242 (description; Ebon, Marshall Islands).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 23 (=*Stephanometra monacantha*).

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(Zool.), vol. 36, 1929, p. 641; Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (reason for changing name to *protectus*).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 20, 25.

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Antedon zebrinus (Lütken, MS.) A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 117 (identity).

Stephanometra marginata A. H. Clark, Amer. Nat., vol. 43, 1909, p. 255 (recorded by Chadwick from Suez, but record doubtful); Vid. Medd. Naturh. Foren. København, 1909, p. 169 (in part; but not specimen recorded from Singapore, which is *spicata*); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 5 (possibly the same as *Antedon marginata* recorded by Chadwick from the Red Sea), p. 9 (northeast coast of Africa), p. 26 (references to African specimens; localities; range; identity of African specimens doubtful); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 28 (published references to the specimen in the B. M.; *Challenger* station 208; character of proximal pinnules).—Gislén, Arkiv för Zoologi, vol. 19, 1928, p. 6, No. 19 (*S. monacantha;* notes).

Stephanometra indica A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 26 (in part; Ceylon; Maldive Islands; Bay of Bengal); Rec. Indian Museum, vol. 7, pt. 3, 1912, p. 269 (lat. 8°51′30″ N., long. 81°11′52″ E.; 28 fathoms); Crinoids of the Indian Ocean, 1912, p. 135 (in part; Maldives; Tuticorin); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 29 (in part; Tuticorin; Maldives); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 97 (station 301; Mer), p. 276 (listed).

Antedon militaris (Hartlaub, MS.) A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 21 (name found with a specimen from Mortlock Island); Crinoids of the Indian Ocean, 1912, p. 136 (identity).

Antedon spicata (Brit. Mus., MS). A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 136 (identity).

Antedon ?spicata (Brit. Mus., MS). A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 29 (Male, Maldives; identity).

Stephanometra protecta A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641; Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 557 (Addu Atoll; notes).— Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank); p. 6 (range).

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Stephanometra monacanta Gislén, Arkiv för Zoologi, vol. 19, No. 32, 1928, p. 6, No. 19 (identity of *Antedon marginata*).

Stephanometra indica protectus A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 88 (comparison with *S. i. indica*), p. 100.

Lamprometra protectus Boone, Bull. Vanderbilt Marine Mus., vol. 7, 1938, p. 110 (Bali), p. 120 (details of locality; references, distribution, and color notes refer to *Lamprometra palmata*), pl. 37, facing p. 120.

Diagnostic features.—The outer cirrus segments are wholly without dorsal processes, being merely more or less sharply carinate in the middorsal line; P_1 is flexible, flagellate, delicate, and slender, much smaller and weaker than P_2; P_2 is stout, very stiff, abruptly and sharply pointed, usually straight, more rarely somewhat recurved, with 9–16 (usually 11–15) segments, of which the fourth and fifth are typically abruptly longer than the others; P_3 is small, flexible and weak like the pinnules following; there are 13–31 (usually about 15, 20, or 30) arms 40–125 (usually 60–90) mm. long; and the cirri have 16–27 (usually about 20) segments.

Description.—The centrodorsal is discoidal, with strongly sloping and swollen sides or low hemispherical, with the bare, small, and usually flat dorsal pole about

2 mm. in diameter. The cirrus sockets are arranged in from two to three more or less irregular crowded alternating marginal rows.

The cirri are XXI–XL (usually XXX–XXXV), 16–27 (usually 19–23), 15–23 (usually 15–20) mm. long. The first segment is short, and those following increase in length to the fourth, which is about as long as broad. The segments succeeding are at first about half again as long as broad, later decreasing in length and becoming as long as broad after the tenth. There are no dorsal processes. The distal segments are laterally compressed and bear dorsally a more or less marked median keel. The earlier segments have the distal end somewhat thickened and the distal edge produced, especially on the ventral side. The opposing spine varies from small to well developed. It is terminal and is directed obliquely forward. The terminal claw varies from short to longer than the penultimate segment and is usually slender and moderately curved.

The radials may be wholly concealed or visible only in the interradial angles, or their distal ends may project slightly beyond the rim of the centrodorsal. The IBr_1 are oblong, short, three or four times as broad as long, and entirely free laterally; they are provided on each side with a rounded ventrolateral projection. The IBr_2 (axillaries) are more or less pentagonal, about half again as long as the IBr_1, varying from slightly broader than long to nearly twice as broad as long. The IBr series are rather short. The IIBr series are 2. The IIIBr series are 2 but are rarely present; if present they occur only on the outer side of a IIBr axillary. The IIBr and IIIBr series resemble the IBr series, but the first ossicle is proportionately somewhat longer. The division series are rather strongly convex dorsally and widely free laterally; each of the component ossicles, and also the first two brachials, bear a more or less strongly developed rounded or somewhat irregular process. More or less prominent synarthrial tubercles are present on the division series and between the first two brachials.

The arms are 11–31 in number. Most frequently there are 13–16, or 20, or 28–30 arms; other numbers are of infrequent occurrence. In fully grown individuals the arms vary in length from 60 to 125 mm., being most commonly between 65 and 90 mm. They consist of about 150 brachials. The first five or six brachials are short and oblong, and those following are obliquely wedge-shaped, almost triangular, half again as broad as long or even broader, and those succeeding gradually become less and less obliquely wedge-shaped, and terminally practically oblong. The first syzygial pair (composed of brachials 3+4) is somewhat broader than long. The arms are smooth. The division series and proximal brachials are widely free laterally. The two ossicles immediately following each axillary are interiorly united basally but free distally.

Syzygies occur between brachials 3+4, again from between brachials 13+14 to between brachials 21+22 (most commonly between brachials 13+14 or 14+15), and distally at intervals of 2–12 (usually 4–7) muscular articulations. On arms arising directly from a IBr axillary the second syzygy is usually between brachials 9+10.

P_1 is 4.5–13 (averaging about 9) mm. long, with 12–27 (averaging 19) segments, slender, weak, tapering, and flexible, rarely somewhat stiffened. The first three segments are about as long as broad, those following becoming elongated so that the distal are from two to three times as long as broad, the terminal slightly shorter. Sometimes the third segment is longer than the first two, about half again as long as broad. P_a is similar to P_1 but somewhat shorter and smaller. P_2 is 8–16 (usually 10–15) mm. long, with 9–18 (usually 12–16) segments, stiffened and rigid, spinelike, and sharp pointed, usually straight though sometimes more or less strongly curved outward toward the arm tip, usually stout, sometimes very stout, more rarely rather slender. It is longer and much stouter than P_1 and tapers more gradually. It is frequently, though not always, markedly longer and stouter on the outer arms of each postradial series than on the inner arms, the corresponding pinnule on the inner arms being of the same size as P_a or somewhat smaller. The first two segments vary from broader than long to about as long as broad, the third varies from the same length as the first two to about twice as long as broad, and those following are greatly elongated, usually about three times as long as broad or even longer, the fourth and fifth being more or less markedly longer than the others, though sometimes the longest segments are the eleventh and twelfth. Usually the ends of the elongated segments are slightly swollen. P_b is similar to P_2 but shorter. P_3 is usually scarcely half as long as P_2, small, weak, and flexible, 4–7 (commonly about 5) mm. long, with 8–15 (usually 10–12) segments. The three or four pairs of pinnules following are similar, after which the pinnules slowly increase in length, the slender distal pinnules being 8 or 9 mm. long.

The disk is 11–15 mm. in diameter and is naked and moderately to strongly incised. The ambulacral grooves have lines of sacculi along their sides, which become very prominent toward the margin of the disk and give off branches to the first pair of pinnules. Along the ambulacral grooves of both arms and pinnules the sacculi are large, abundant, and closely set.

Notes.—The specimen from Macclesfield Bank is small, with the arms 65 mm. long; P_2 has 13 segments.

The specimen from *Challenger* station 208 served Carpenter as the basis for the description of his new species *Antedon marginata*. Carpenter said that the centrodorsal is saucer-shaped. The cirri are XXV, 20. A few of the segments are somewhat longer than broad, and the terminal are rather compressed laterally, having a faint keel that passes into the dorsal spine of the penultimate—that is, the opposing spine. The radials are just visible beyond the rim of the centrodorsal. The IBr_1 are oblong and are quite free laterally. The IBr_2 (axillaries) are pentagonal and about half again as long as the IBr_1. The IIBr series are 2. The IBr and IIBr series are rather convex, rising sharply to the middle of their apposed edges—that is, synarthrial tubercles are present. The ventrolateral borders of all the ossicles from the IBr_1 to the second brachials inclusive are marked by irregular projections toward the ventral side. The 14 arms are 100 mm. long and consist of about 150 brachials, of which the lower are thick disks and their successors are more triangular, though wider than long, gradually becoming quadrate and more discoidal again in the middle of the arm. Syzygies occur between brachials 3+4, again from between brachials 9+10 to between brachials 14+15, and distally at intervals of from 4 to 7 muscular articulations.

P_1 is comparatively slender and consists of about 20 segments, most of which are longer than broad. P_a is similar, but smaller. P_2 and P_b are not much longer than the pinnules of the first pair, reaching 10 mm. in length, but they have only 10–12 very stout and rather elongated segments, which terminate somewhat abruptly. P_2 is larger than P_b. P_3 and P_c are of the same character as P_2 and P_b, but less stout, though not much shorter. The following pinnules become more slender and gradually increase in length. The disk is 15 mm. in diameter, naked and moderately incised. The ambulacral grooves have lines of sacculi at their sides, which become very prominent toward the margin of the disk, and give off branches to the first pair of pinnules. The sacculi are large and abundant along the ambulacra of both arms and pinnules. The color in alcohol is reddish white, with dark-red lines at the articulations; the ventral perisome is gray or purplish gray.

Carpenter said that the pinnules of the second pair (P_2 and P_b) in this unique specimen of *Antedon marginata* terminate so abruptly that they seem to have been broken off by some accident and not completely repaired. The diameter of the segments suddenly decreases, and there are from one to four quite small segments at the end of a large and stout one which is considerably longer than broad. He noted further that the disk of this specimen is remarkable for the abundance of sacculi upon it. There is a line of them along each side of the ten secondary ambulacra, and branches proceed direct from these lines to the primary pinnules, thus marking the course of their water vessels which, however, have no tentacular extensions.

I examined this specimen at the British Museum in 1910. P_3, though not especially enlarged and about the length of the succeeding pinnules, is more of the character of P_2 and is somewhat stouter than those succeeding; it is flagellate distally. P_2 curves strongly backward and is not erect as is usual in *S. protectus.* At that time I regarded *marginata* as possibly a form of *protectus* ("*monacantha*"), though probably distinct. Dr. Torsten Gislén examined this specimen in 1925. He identified it as *monacantha* (=*protectus*). He wrote that only P_2 is stiffened, Carpenter's description being not quite correct in this particular.

Two of the specimens from Port Galera, Mindoro, are large with 16 arms.

In one of the specimens from Santa Cruz Island, Zamboanga, there are 20 arms 80 mm. long. Ten IIBr 2 series are present. The cirri are XXVII, 19–20, from 16 to 18 mm. long. P_2 is 13 mm. long and is composed of 16 segments. This pinnule is markedly longer and stouter on the outer arms of each postradial series than on the inner, the corresponding pinnule on the inner arms being of the same size as P_a, or somewhat smaller. Another specimen has 20 arms 90 mm. long. A third specimen has 14 arms 80 mm. long; P_2 is 14 mm. long with 15 segments. A fourth specimen has 13 arms 80 mm. long; P_2 is 10 mm. long with 12 segments. There are eight additional specimens.

The example from *Siboga* station 96 has 17 arms and is undergoing adolescent autotomy. P_2 has 9 segments, of which the first two are about as long as broad and the third is twice as long as broad.

In the two specimens from Mortlock Island described by Hartlaub the centrodorsal is moderately thick, convex, with convex sides; the bare dorsal pole is small and pitted. The cirrus sockets are arranged in three irregular rows. The cirri are XXX–XXXV, about 20. They are laterally compressed. From the fifth onward the segments are longer than broad, toward the end of the cirri gradually becoming shorter again. They bear dorsally neither tubercles nor spines. Seen from above they are somewhat hourglass-shaped, their distal end being thickened and the distal edge being produced, especially on the ventral side. The surface of the cirri is thus uneven. The radials are only slightly or not at all visible. The IBr_1 are entirely free laterally. The IBr_2 (axillaries) are more or less pentagonal; both the IBr_1 and IBr_2 are rather short. The IIBr series are 2. IIIBr series are absent or of sporadic development. The ossicles from the IBr_1 to the first and occasionally also the second brachials bear on the outer side a rather strong lateral extension. On the axillaries this has an oblique position and pertains partly to the proximal border of the ossicle. The arms are about 20 in number and are about 85 mm. long. One of the two specimens from Mortlock Island has 17 arms. The arms are smooth. The first brachials are almost rhombic. The second are of the same size as the first. Their proximal edge is bowed outward posteriorly, and on arms arising from a IBr axillary their lateral borders are thickened. The first syzygial pair (composed of brachials 3+4) is somewhat broader than long. The three following brachials are approximately discoidal. From the ninth onward the brachials are almost triangular, soon becoming shorter and more bluntly wedge-shaped; at the end of the arms they are more squarish. The first syzygy is between brachials 3+4, the second is at about brachials 13+14, and the distal intersyzygial interval is three to five muscular articulations. On arms arising from a IBr axillary the second syzygy is between brachials 9+10.

P_1 is delicate, slender, and flexible, with 15, or at the highest 20, segments most of which are longer than broad. It is longer than P_a but usually only half as long as P_2. P_2 and P_b are much thicker and are stiffened throughout, straight and spinelike. They are 9–10 mm. long and are composed of 12 greatly elongated segments, of which the fourth and fifth are markedly the longest. P_3 and P_c are not half so long as P_2 and P_b; they are flexible and of the same character as the pinnules succeeding. Of these last the first three or four pairs are of approximately the same length, those following becoming longer and reaching 8 mm. The disk is 11 mm. in diameter and is strongly incised. Sacculi are abundant and closely set on the pinnules. The color in alcohol is light brown, sometimes with broad dark-brown bands on the arms. The disk is dark brown. The specimen from Ebon, Marshall Islands, in the Museum of Comparative Zoology, was described as a new species, *Himerometra heliaster*, in the following terms: The centrodorsal is low hemispherical or thick discoidal, with the cirrus sockets in two or three more or less irregular marginal rows. The cirri are XXX–XXXV, 17–23, from 20 to 23 mm. long. The segments are mostly rather longer than broad, and the distal are without dorsal spines. The opposing spine is well developed. The terminal claw is short and curved. The radials are concealed. The IBr_1 are oblong, short, about four times as broad as long. The IBr_2 (axillaries) are pentagonal and somewhat broader than long. The IBr series are well rounded dorsally and are widely free laterally, and they bear a slight synarthrial tubercle. The IIBr and IIIBr series are 2; the axillaries resemble the IBr axillaries, but the preceding ossicle is proportionately somewhat longer than the IBr_1. The arms are 25–30 in number and 125 mm. long. The first five or six brachials are oblong and slightly tubercular, those succeeding are wedge-shaped, the seventh or eighth is nearly triangular, much broader than long, and those following become gradually less and less obliquely wedge-shaped, and practically oblong at the tips of the arms. Syzygies occur between brachials 3+4, again from between brachials 17+18 to between brachials 21+22, and distally at intervals of from 2 to 12 (usually 6 or 7) muscular articulations.

P_1 is 9 mm. long, slender and flagellate, with 25 segments, of which the first three are about as long as broad and those succeeding gradually become elongated, about twice as long as broad or even a little longer in the outer third of the pinnule, then short again terminally. P_2 is 15 mm. long, much stouter than P_1, stiff, composed of 15 segments of which the first three are about as long as broad and those following rapidly become elongated reaching a maximum length, on the eleventh or twelfth, of somewhat over three times the width. P_3 and the following pinnules are much shorter than P_1, being only 5 mm. long, and are composed of 12–15 segments; later the pinnules become gradually longer and more slender, the distal pinnules being 9 mm. long. The ossicles immediately following each axillary are interiorly united basally, but are free distally. The division series and the brachials are widely free laterally. In one arm of the type specimen the first four brachials are united into two syzygial pairs. The color in alcohol is grayish brown.

Hartlaub recorded a fine specimen from Ebon, Marshall Islands, which he said had been collected by the Rev. B. G. Luon in 1877. It was part of the lot that included the specimen just described and was collected by the Rev. B. G. Snow. Hartlaub said that it is somewhat larger than his type specimens from Mortlock Island and Torres Strait [the last represents *indica*], but otherwise it agrees completely with them except in its color and in the number of its arms. There are 29 arms. Four of the postradial series bear each 2 IIIBr series, which are externally developed. P_3 is very small, not half so long as the spiniform P_2. The skeleton is a uniform light brownish white. Individual arms have light-brown cross stripes. The disk is light gray, and in some places light brown. The borders of the ambulacral grooves are dark slate gray.

One of the specimens from Fiji was described by me as a new species, *Himerometra acuta*, in the following terms: The centrodorsal is discoidal or low hemispherical. The cirri are about XXXV, 20, 20 mm. long. About half of the segments are rather longer than broad and the remainder are about as long as broad. The terminal segments are rather compressed laterally and have a faint dorsal keel that passes into the opposing spine. The radials are just visible in the interradial angles of the calyx. The IBr_1 are short, oblong, free laterally, and furnished with a rounded lateral projection. The IBr_2 (axillaries) are low pentagonal, nearly twice as broad as long. The IIBr series are 2. The articulations between the elements of the division series and the lower brachials are more or less tubercular. The elements of the division series have rounded lateral projections. The 20 arms are 85–90 mm. long. The first six brachials are oblong, and those following are obliquely wedge-shaped, almost triangular, about half as long as broad, becoming less obliquely wedge-shaped and finally oblong distally. P_1 is 4.5 mm. long, slender, weak, and tapering, with 12–13 segments of which the first three are short and those following become progressively longer. P_2 is 10 mm. long, much stouter than P_1, stiff and styliform, with 15 segments, of which the first two are broader than long and the remainder are elongated. The succeeding pinnules are shorter than P_1, and are composed of about 8 segments; later the pinnules gradually increase in length distally. The color in formalin is yellow-brown, the skeleton dull yellow.

In the specimen from the Tonga Islands the cirri are XXIII, 16–20 (usually 19), from 10 to 15 mm. long. There are 28 arms about 60 mm. long. The IIIBr series are developed externally in 2, 1, 1, 2 order. P_1 is about 10 mm. long, stiff like P_2 but more slender, with about 14 segments, of which the first two are about as long as broad, the next is half again as long as broad, and the remainder are from two and one-half to three times as long as broad. P_2 is 12 mm. long, with 10–12 segments, of which the first is about as long as broad, the third is twice as long as broad, and those following are three times as long as broad. P_3 is not much more than half as long as P_2; it is slender and slightly stiffened and is composed of 9 or 10 segments. P_4 and the following pinnules are 4 mm. long and are slender and flexible. This specimen differs from the type of *monacantha* from Mortlock Island in the greater length and stiffness of P_1, and in the greater number of arms.

The specimen from New Caledonia has 21 arms. The cirri have 19 or 20 segments. P_2 has 13 segments.

The specimen from Sissie has 11 arms about 25 mm. long.

The example from Batoe Ata is small, with 13 arms about 70 mm. long.

The specimen from Beo, Talaut Island, is young, with 15 arms 50 mm. long.

In the specimen from *Siboga* station 301 the 20 arms are 115 mm. long. The flat dorsal pole of the centrodorsal is 2 mm. in diameter. The cirri are XXXIII, 20–21, 20 mm. long. P_2 is 15 mm. long with 15 or 16 segments, of which the fourth and fifth are the longest. On the inner arms P_2 is 12 mm. long, though composed of the same number of segments as on the outer. P_2 is relatively slender, much less spinelike than usual, more flexible basally and becoming very slender distally; the three basal segments are about as long as broad, the fourth is about one-third again as long as broad, and the remaining segments are elongated. It agrees with specimens from Ceylon, with which it was directly compared.

The specimen from *Siboga* station 250 has 14 arms 55 mm. long. The cirri are 11 mm. long. P_2 is 6.5 mm. long, with 10–12 (usually 11) segments.

All the specimens from *Siboga* station 89 are small. One has 15 arms 40 mm. long. The cirri have 17 segments, of which the proximal are proportionately more slender than in larger examples. P_2 is proportionately more slender than in the adults, is slightly recurved, and is composed of 10 proportionately longer segments. P_3 resembles the following pinnules. Another specimen has 20 arms 70 mm. long. The cirri are about 16 mm. long, with 19 segments. P_2 is 8 mm. long, with 11 segments. P_3 resembles P_4. A third example has 18 arms 65 mm. long. The cirri are 15 mm. long, with 19 segments. P_2 is 9 mm. long, with 11 segments. Of the remaining specimens three have 15 and four have 14 arms. In one of the latter P_2 has 12 segments. One individual, not included in the preceding enumeration, is small and much broken.

The figure published by Miss Boone of the specimen from Bali shows a typical example of the form with slender pinnules. The arms are apparently about 115 mm. long.

The specimen from the Sunda Strait that Hartlaub found in the Lübeck Museum has 20 arms. The cirri are arranged in two rows on the centrodorsal. The arms are slender. There are no IIIBr series. The lateral thickenings of the ossicles of the division series are very characteristic. The color is remarkable in that, especially in the lighter proximal portion of the arms, the ends of the brachials are much darker (violet) colored than the remaining portion, and therefore very conspicuous. Moreover, here and there cross bands that are broader than usual occur.

The specimen from Singapore is large with 31 arms 100 mm. long and in general resembles the one from the Tonga Islands. The cirri are XXVIII, 20–23, from 15 to 20 mm. long. The IIIBr series are developed externally in 2,1,1,2 order. P_1 is very slender, 12 or 13 mm. long, with 22–27 segments. P_2 is very stout and stiff, 15 mm. long, with 12 or 13 segments. P_3 is 7 mm. long, slightly stouter basally than P_1, rapidly tapering, with 12 segments. P_4 and the following pinnules are small and weak, 4 mm. long, with 10 segments.

The specimen from the Nicobar Islands has exactly 20 arms 105 mm. long, the delicate and feathery distal portions of which are remarkably well preserved. The cirri are XXI, 18–19, from 15 to 17 mm. long. The first segment is short, and those following increase in length to the fourth, which is about as long as broad. The segments succeeding are at first about half again as long as broad, later decreasing in length and becoming about as long as broad after the tenth. There are no dorsal spines or tubercles. The opposing spine is small, terminally situated, and directed obliquely forward. The terminal claw is longer than the penultimate segment and is slender and moderately curved. The long earlier segments of the cirri are somewhat constricted centrally. P_1 is small, 7 mm. long with about 18 segments. P_2 is much enlarged, stiff and spinelike, 12 mm. long, with 14 segments. P_3 is only 5 mm. long.

The specimen from Port Blair, Andaman Islands, has 30 arms 90 mm. long. P_2 is 12 mm. long, with 12 or 13 segments.

The specimen from the Andaman Islands has 19 arms 70 mm. long. P_2 has 11 or 12 segments.

Of the two specimens examined from Tuticorin, Madras, one is large, and the other is a beautiful example with 30 arms 110 mm. long; P_2 is rather longer than usual, and is composed of 15 or 16 segments.

The five specimens from *Investigator* station 175 are all small. One has 13 arms 70 mm. long and P_2 10 mm. long, with 15 or 16 segments. Another is similar, with 16 arms. The third has 20 arms 50 mm. long; P_2 has 14 or 15 segments. In one P_1 has 15 segments.

Most of the 10 specimens from Ceylon that Reichensperger studied were large. The smallest had 24 arms 75 mm. long. All the others had 27–30 arms 85 to 95 mm. long. The cirri were XXX–XL, 20–27, agreeing with Hartlaub's description; there were no traces of dorsal processes. The long and rigid P_2, which is sometimes slightly recurved distally, may reach a length of 17 mm., but generally it is not over 15 mm. long; it is composed of 12–18 (usually 12–14) segments. The color in alcohol varies from blackish or chocolate brown to light brown, and is often darker ventrally than dorsally. Commonly the dorsal skeleton is light brownish with the articulations dark brown.

The specimen from Hulule, Male, Maldives, has 30 arms about 85 mm. long; as is usual in specimens of species of this genus having 30 arms, all the IIIBr series are externally developed. The cirri are XXIX, 22–23, 20 mm. long. P_2 is 14–16 mm. long with 13–15 segments. P_3 is small and weak like P_4, and is not more than half as long as P_1. This specimen is very similar to the somewhat larger one from Tuticorin mentioned above.

The specimen from Male, Maldives, has 25 arms and resembles the preceding but is slightly larger. P_2 has 13–16 segments.

The specimen from Muhlos, Maldives, has 14 arms 65 mm. long. P_1 is long and very slender. P_2 is enlarged and stiff, but distally flagellate, with 15 segments. P_3 and the following pinnules are scarcely more than half as long as P_2. The cirri are smooth with 17–19 segments, of which the shorter are slightly carinate.

Judged from the evidence afforded by the youngest specimens, the relative proportions of the lower pinnules in the 10-armed stage are quite the same as in the adults, but P_2 is relatively more slender with more prominent articulations and is somewhat recurved.

Remarks.—On the coast of Ceylon and on the adjacent coast of India this form appears to intergrade, at least to some extent, with *S. indica*. In the 10 specimens recorded by Reichensperger from Ceylon P_2 was composed of 12–18 (usually 12–14) segments, and in one of those from Tuticorin and in some from *Investigator* station 175 P_2 in some cases had 16 segments. Apparently a similar increase in the number of segments in P_2 occurs in the Lesser Sunda Islands, for in the specimen from *Siboga* station 301 P_2 sometimes has 16 segments.

Habits.—Dr. Hubert Lyman Clark said that the single specimen that he found on the southwestern reef at Mer, Murray Islands, Torres Strait, was an active and very graceful swimmer.

Localities.—Macclesfield Bank; 24 meters [Bell, 1894; A. H. Clark, 1912, 1913] (1, B. M.).

Albatross station 5109; China Sea, off southern Luzon; Corregidor Light bearing N. 42° E., 25.8 miles distant (lat. 14°03′45″ N., long. 120°16′30″ E.); 22 meters; coral bottom; January 15, 1908 [A. H. Clark, 1908, 1912] (1, U.S.N.M., 35262).

Challenger station 208; Philippine Islands (lat. 11°37′ N., long. 123°31′ E.); 33 meters; blue mud; January 17, 1875 [von Graff, 1887; P. H. Carpenter, 1888; Hartlaub, 1891; A. H. Clark, 1907, 1908, 1909, 1912, 1913] (1, B. M.).

Port Galera, Mindoro, Philippines; Dr. Lawrence E. Griffin, April to June, 1912 [H. L. Clark, 1921 (as Philippines)] (3, M. C. Z., 688, 689).

Dr. Th. Mortensen's Pacific expedition, 1914–1916; Santa Cruz Island, Zamboanga; coral reef; February 25–28, 1914 (12).

Albatross station 5147; Sulu archipelago, in the vicinity of Siasi; Sulade Island (E.) bearing N. 3° E., 8.4 miles distant (lat. 5°41′40″N., long. 120°47′10 E.); 38 meters; coral sand and shells; February 16, 1908 [A. H. Clark, 1908, 1912] (1, U.S.N.M., 35221).

Siboga station 96; Sulu archipelago, southeastern side of the pearl bank; 15 meters; lithothamnion bottom; June 27, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Mortlock Island, Carolines [Hartlaub, 1890, 1891; A. H. Clark, 1909, 1912] (1, H. M.).

Ebon, Marshall Islands; Rev. B. G. Snow, 1877 [A. H. Clark, 1908, 1912; H. L. Clark, 1921] (1, M. C. Z., 290).

Ebon, Marshall Islands; Rev. B. G. Snow, 1877 [Hartlaub, 1912].

Tutuila, Pago Pago, Samoa [H. L. Clark, 1921] (2, M. C. Z., 734, 753).

Fiji; beach at Suau Point, Vauna Mbalavu; Alexander Agassiz, November 25, 1897 (4+, U. S. N. M., 35232; M. C. Z., 58, 206, 288 [type of *Himerometra acuta*]).

Fiji [P. H. Carpenter, 1881].

Tonga Islands [Lütken, 1874; A. H. Clark, 1909, 1912] (1, C. M.).

New Caledonia; M. Reveillière, 1880 [A. H. Clark, 1911, 1912] (1, P. M.).

Mer, Murray Islands, Torres Strait; southwestern reef; H. L. Clark, October 11, 1913 [H. L. Clark, 1915, 1921] (1, M. C. Z., 599).

Sissie, near Misool; shore and reef; *Willebrord Snellius*, October 6, 1929 [A. H. Clark, 1936] (1, L. M.).

Batoe Ata; 7 meters; *Willebrord Snellius*, March 6, 1930 [A. H. Clark, 1936] (1, L. M.).

Obi latoe; shore and reef; *Willebrord Snellius*, April 23–27, 1930 [A. H. Clark, 1936] (2, L. M.).

Beo, Talaud Islands; 6–10 meters; *Willebrord Snellius*, June 14–21, 1930 [A. H. Clark, 1936] (1, L. M.).

Siboga station 301; off southwestern Timor (lat. 10°38′00″ S., long. 123°25′12″ E.); 22 meters; mud, coral, and lithothamnion; January 30, 1900 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 250; anchorage off Kilsuin, west coast of Kur Island; 27 meters; coral and lithothamnion; December 6–7, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 89; Pulu Kaniungan ketjil; 11 meters; coral; June 21, 1899 [A. H. Clark, 1918] (11, U.S.N.M., E. 428; Amsterdam Mus.).

Temukus roads, Bali; on coral reef; yacht *Alva*, October 25, 1931 [Boone, 1938].

Sunda Strait; Captain Storm [Hartlaub, 1912].

Singapore [A. H. Clark, 1934] (1, Raffles Mus.).

Singapore; Svend Gad [A. H. Clark, 1909, 1912] (1, C. M.).

Nicobar Islands; *Galathea* Expedition [A. H. Clark, 1909, 1912] (1, C. M.).

Investigator; Port Blair, Andaman Islands [A. H. Clark, 1912] (1, U.S.N.M., 35223).

Investigator; Andaman Islands [A. H. Clark, 1912] (1, I. M.).

Tuticorin, Madras [Bell, 1888; Thurston, 1894; A. H. Clark, 1912, 1913] (2, B. M.).

Investigator station 175; off northeastern Ceylon (lat. 8°51′30″ N., long. 81°11′52″ E.); 51 meters; April 20, 1894 [A. H. Clark, 1912] (5, I. M.).

Ceylon; Doctor Sarasin [Reichensperger, 1913; H. L. Clark, 1915].

Hulule, Male, Maldives [Bell, 1902; A. H. Clark, 1912, 1913] (1, B. M.).

Male, Maldives [A. H. Clark, 1912, 1913] (1, B. M.).

Muhlos, Maldives [A. H. Clark, 1912, 1913] (1, B. M.).

Geographical range.—From the Macclesfield Bank and the Philippine Islands to the Caroline and Marshall Islands, Samoa, Fiji, the Tonga Islands, New Caledonia, and Torres Strait, and westward to Ceylon and the Maldive Islands.

Bathymetrical range.—From the shoreline down to 51 meters; most of the records are from the shoreline or from very shallow water.

History.—This species was first mentioned by Prof. Christian F. Lütken in 1874 under the name of *Antedon protectus*. This name appeared as a *nomen nudum* with the locality "Tonga Islands" in the catalog of the Godeffroy Company of Hamburg.

In 1879 Dr. P. H. Carpenter published a long quotation from an unpublished manuscript by Professor Lütken containing descriptions of new species of comatulids. In this manuscript Professor Lütken said: "Moreover the lower or oral pinnules of *Actinometra* are always very different from the others, being flagelliform and presenting a more or less distinct serrature or comb (pinnulae orales prehensiles); while in *Antedon* they are only slightly differentiated from the others, or are transformed into strong rigid spines, forming a protective covering over the disk [*A. protectus*, mihi]."

This notice of *Antedon protectus* identifies it as a species of *Stephanometra*. The only species of *Stephanometra* known in the Tonga Islands is the present one, which has been recorded from that region only from specimens that had passed through Lütken's hands. Therefore the *Antedon protectus* recorded in 1874 and said in 1879 to possess strong, rigid, and spinelike pinnules must be this species.

In his original description of *Stephanometra spicata* published in 1881 Carpenter said that it is closely allied to the Fijian *Antedon protecta* Lütken, MS., which has nearly L cirri, smoother brachials, and a relatively smaller P_b; but the stiff and pointed lower pinnules are striking features of both species.

In the *Challenger* report on the stalked crinoids published in 1884 Carpenter in speaking of the lowest pinnules of the comatulids said that "they may be stiff, straight, and spinelike, as in *Antedon protecta*." Evidently he here referred to the present species.

In 1887 in the *Challenger* report on the myzostomes Prof. Ludwig von Graff listed *Antedon marginata* from station 208 as a host for myzostomes. The name, which was given him by Carpenter, appears as a *nomen nudum*.

In the *Challenger* report on the comatulids published in 1888 Carpenter described *Antedon marginata* as a new species. He noted that in the lateral freedom of its division series and in the presence of irregular processes at their sides *marginata* resembles *tuberculata* (=*spicata*), but he said that it differs from that form in having a smaller number of cirri and no IIIBr series, so that there are only 14 arms instead of 30, while the length of the first pinnules is much more nearly equal in *marginata* than is the case in *tuberculata*.

In the *Challenger* report Carpenter used the name *Antedon protecta* Lütken, MS., for a form quite different from that to which he had previously applied it, a minor variety of *Lamprometra palmata* in which the enlarged oral pinnules are not stiff and spinelike but taper gradually to a more or less delicate tip. He was apparently led into this error through the receipt of a specimen of *L. palmata* from Prof. Sven Lovén that had been labeled *Antedon protecta* by Professor Lütken.

In his list of the species of the genus *Antedon* with their specific formulae "one or two of Professor Lütken's MS. names are included, as they belong to easily recognizable types, *e. g.*, *Antedon protecta*." He listed *A. protecta* under the formula A.2.2., indicating that it is an "*Antedon*" possessing IIBr 2 and IIIBr 2 series. Further on he said that "in *Antedon occulta* [=*palmata*], and in a large number of similarly bidistichate species, they [the oral pinnules] are stiff and styliform and stand up round the edge of the disk as if to shield it from danger, a character which Lütken has expressed in the specific name *Antedon protecta*."

In his key to the species of the *Palmata* group he paired *protecta* with *conjungens* under the headings P_a present; two or more axillaries following the IBr axillary; P_2 larger than P_3; division series free laterally; P_2 has 25 or more segments which are not specially elongated; and lower pinnules larger on the outer arms of each IIBr series than on the inner arms. He said that in *protecta* P_3 is quite short, whereas in *conjungens* P_3 is not especially short, being nearly as long as P_2 on the inner arms.

The group under the heading P_2 with 25 or more segments, which are not specially elongated, including *protecta* and *conjungens*, was contrasted with a group headed P_2 stiff and styliform, of 12–18 much elongated segments, which included *tuberculata* [=*Stephanometra spicata*], *spicata* [=*S. spicata*], and *indica* [=*S. indica*]. Under the heading *Antedon conjungens* he said:

> A similar variation is presented by one of the types which have been distributed by the Godeffroy Museum under the MS. name *Antedon protecta* Lütken. Thus in an individual, which I owe to the kindness of Professor Lovén, the first two pinnules on the outer pair of every four tertiary arms are greatly larger than the corresponding pinnules on the inner arms. The second one has twenty-five joints and reaches 12 mm., nearly three times the length of its fellow on the inner arm. In this type, however, the third pinnule on both inner and outer arms alike has little more than a dozen joints, and is only some 4 mm. long. The small size of this third pinnule is remarkable, not only as distinguishing the type from *Antedon conjungens*, in which it is at least half the length of the second pinnule, if not more, but also in the whole group of species with large second pinnules.

Later under the heading *Antedon occulta* Carpenter said:

> In the individual which shows the greater inequality of the pinnules on the outer and inner arms, they [the lower pinnules] are generally stiffer and more styliform than in the more regular example. The latter thus presents an approach toward *Antedon conjungens*, while the former rather resembles *Antedon protecta*. These two species, however, have much less closely approximated rays and a smaller centrodorsal, which leaves the second radials [IBr_1] visible as well as the axillaries [IBr_2].

In 1890 Dr. Clemens Hartlaub described this species as new under the name of *Antedon monacantha*, describing it in greater detail and figuring it in 1891. His type material consisted of two specimens from Mortlock Island, one at Göttingen and one at Hamburg (the latter bearing the manuscript name *Antedon militaris* Hartlaub), and one specimen from Torres Strait. This last is herein referred to *Stephanometra indica*.

In his key to the species of the *Palmata* group published in 1891 Dr. Clemens Hartlaub placed *marginata* with *clemens* (=*Heterometra quinduplicava*) in a special category including species with IIBr series but no further division, and the division series entirely free laterally. He gave *marginata* as having 20 cirrus segments and the brachials not especially short, and as possessing irregular processes at the sides of the division series, while *clemens* has 30 cirrus segments and the brachials very short, and the sides of the division series smooth. With species possessing IIIBr and sometimes additional division series he placed *spicata*, *tuberculata*, and *indica*.

In 1894 Prof. F. Jeffrey Bell described as a new species *Antedon flavomaculata* from the Macclesfield Bank in 13 fathoms (24 meters). He assigned this new species to Carpenter's *Spinifera* group of *Antedon*. His description was as follows:

> Bidistichate, with (in the single known specimen) exactly 20 arms; about 30 cirri, with 16 smooth joints, and the centre of the low centrodorsal bare of cirrus-sockets. The first syzygy is on

the third brachial, the next on or about the thirteenth. The most proximal brachials are square, those that succeed them are triangular. The second pinnule is very long and stiff, much longer than the first or third. Arms purplish, with yellowish dots and patches; the cirri yellowish at base and purplish at tip.

Spread 120 mm.; diameter of disc 6 mm.
Macclesfield Bank, 13 fms.

In 1902 Professor Bell recorded *Actinometra maculata* "from the west reef of Hulule, and very commonly seen at shallow depths on lagoon reefs in all the more open atolls of the Maldives." The single specimen from Hulule labeled *Actinometra maculata* in the British Museum represents the present species; whether the other specimens were the same I do not know.

In my first revision of the old genus *Antedon* published in 1907, I referred Hartlaub's *monacantha* (which I misspelled *monocantha*) to my new genus *Himerometra*. In the list of the species of *Himerometra* there appears as a *nomen nudum* the name *Himerometra helianthus*.

In 1908 I recorded *Himerometra monacantha* from *Albatross* stations 5109 and 5147 in the Philippines, and in another paper described as new species *Himerometra acuta* from Fiji and *H. heliaster* from Ebon, Marshall Islands, the latter being the form to which I referred in 1907 as *Himerometra helianthus*. In a list of the names that had been applied to recent crinoids published in the same year, I said that Bell's *Antedon flavomaculata* is not recognizable from the description. Although described in the *Spinifera* group, this is probably a member of the *Palmata* group, possibly of the *Multicolor* group, but certainly not of the *Spinifera* group.

In my revision of the Himerometridae published in 1909 I referred *acuta* and *monacantha* to the new genus *Stephanometra*, at the same time referring *heliaster* to the new genus *Dichrometra*. In another paper published in 1909 I recorded and gave notes upon specimens of *Stephanometra monacantha* in the collection of the Copenhagen Museum from the Nicobar Islands, the Tonga Islands, and Singapore, and identified Lütken's manuscript name *Antedon zebrinus* as referring to this species.

In a paper on African crinoids published in 1911 I compared *Stephanometra monacantha* and *S. indica*, and in a paper on the crinoids of the Leyden Museum I compared the cirri of *S. monacantha* with those of *S. spicata*. In a paper on the crinoids of the Paris Museum also published in 1911 I recorded and gave notes on a specimen from New Caledonia. In a memoir on the crinoids of Australia and in another on the crinoids of southwestern Australia, both published in 1911, I included *S. monacantha* in the Australian fauna on the basis of Hartlaub's specimen from Torres Strait, which is in reality *S. indica*.

In 1912 Hartlaub recorded and described a specimen of *Antedon monacantha* from Ebon, Marshall Islands, collected by the Rev. B. G. Luon (a misspelling for Snow) in 1877. This specimen was one of the same lot from which came the type of *Himerometra heliaster* described by me in 1908. Hartlaub also recorded and gave notes on another specimen in the Lübeck Museum collected in the Sunda Strait by Captain Storm.

In a paper on the crinoids of the Hamburg Museum published in 1912 I recorded having examined the specimen of *Antedon monacantha* from Mortlock Island described by Hartlaub and noted that it bore the manuscript name *Antedon militaris* Hartlaub.

I added that the specimen of *Antedon monacantha* from Torres Strait recorded by Hartlaub appears to be nearer *S. indica* than *S. monacantha.* In another paper published in the same year I compared the pinnules of *Stephanometra monacantha* with those of *Oligometra marginata*, sp. nov.

In my memoir on the crinoids of the Indian Ocean published in 1912 I gave a complete synonymy of this species, including under *Stephanometra monacantha* Lütken's *Antedon protectus* (in part), the *Antedon palmata* recorded from Tuticorin by Bell and Thurston, *Antedon militaris* Hartlaub, MS., *Antedon spicata* Brit. Mus., MS., *Antedon monacantha* Hartlaub, *Antedon flavomaculata* Bell, and *Himerometra acuta* A. H. Clark. I referred *Himerometra heliaster* A. H. Clark to the genus *Dichrometra.* Specimens collected by the *Investigator* were recorded from off northeastern Ceylon, the Andaman Islands, and Port Blair, Andaman Islands. A complete list of all localities was given.

In 1913 Dr. August Reichensperger recorded and gave notes upon a specimen from Ceylon.

In a paper on the crinoids of the British Museum published in 1913, notes were given on the type specimen of Bell's *Antedon flavomaculata,* which was referred to *Stephanometra monacantha.* The specimens from Tuticorin recorded as *Antedon palmata* by Bell and Thurston, one from Hulule, Maldives, recorded by Bell as *Actinometra maculata,* the specimen from Male, Maldives, labeled *Antedon ?spicata,* and another from Muhlos, Maldives, were recorded as *Stephanometra indica.*

In 1915 Dr. Hubert Lyman Clark recorded this species from Mer Island in Torres Strait, and in another paper he mentioned its occurrence in Ceylon.

In my report upon the unstalked crinoids of the *Siboga* expedition published in 1918, I recorded specimens of *Stephanometra monacantha* from stations 89, 96, and 250. A synonymy of the species was given, and the range was said to be from the Andaman Islands to Singapore, the Philippines, the Malay Archipelago, New Caledonia, Fiji, and the Tonga and Caroline Islands. Under the name of *Stephanometra indica* another specimen was recorded from station 301 that was said to agree with specimens of *indica* from Ceylon. Dr. H. L. Clark's specimen from Torres Strait was also referred to *indica.* The range of *S. indica* was given as Madagascar, the Seychelles, and Rodriguez to Ceylon and southern India, Lesser Sunda Islands, and northern Australia.

In 1921 Dr. Hubert Lyman Clark noted that I had referred his specimen from Torres Strait to *indica* rather than to *monacantha.* He said that he had reexamined the specimen in the light of my key to the species of *Stephanometra* and compared it with what seem to be unquestionable examples of *monacantha* from the Philippines and from Tutuila, Samoa, and he saw no reason to change his original identification, granting, of course, that *monacantha* and *indica* are really distinct. He remarked that after I examined the specimen (M. C. Z., 599) I was satisfied that it really is *monacantha.* In a footnote he said that I had recorded *indica* from Torres Strait in 1918 (that is, in the *Siboga* report), and he had therefore included it in his tabulated list of Torres Strait echinoderms. He said that as he knew nothing of the specimen upon which the record rests, but believed it to be his specimen of either *callipecha* or *monacantha,* he had not included it in the main body of his memoir. The specimen upon which the Torres Strait record was based was the one described by Hartlaub in 1891.

In 1928 Dr. Torsten Gislén published notes on the type specimen of Carpenter's *Antedon marginata* which he had examined in the British Museum in 1925.

In November 1938, Miss Lee Boone recorded this species from Bali, where it had been taken by William K. Vanderbilt during a cruise on his yacht *Alva*. The single specimen was recorded under the name of *Lamprometra protectus*. The references, synonymy, and color notes all refer to *Lamprometra palmata*.

PELOMETRA, gen. nov.

Diagnosis.—A genus of Mariametridae in which the genital pinnules have a narrow expansion on the lower edges of the segments; the cirri have less than 35 segments, of which the distal are sharpened in the middorsal line but are without dorsal processes; the proximal pinnules are enlarged and stiffened but are without spiniform tips, P_3 being the longest; the lateral edges of the elements of the division series are smooth, but abruptly swollen; the division series are not carinate; and the disk is naked.

Genotype.—*Pelometra ambonensis*, sp. nov.

Geographical range.—Known only from Amboina.

Bathymetrical range.—The only record is about 91 meters.

PELOMETRA AMBONENSIS, sp. nov.

PLATE 51, FIGURES 235–237

Description.—The centrodorsal is discoidal, with the dorsal pole flat and marked about the periphery near the bases of the cirri with cirrus scars each containing a flattened boss representing obsolete cirrus sockets. The cirri are arranged in two irregular marginal rows.

The cirri are XXIV, 25–30 (usually 25–26), 20 to 23 mm. in length. The first segment is very short, the second is twice as broad as long, and those following increase in length to the sixth or seventh, which is half again as long as broad. The distal segments decrease slightly in length, the antepenultimate being only one-third or one-quarter again as long as broad. The last 12 to 15 segments have the middorsal line sharpened into a sharp gable, but this is not produced as a carinate ridge. The cirri taper slightly in the last 8 or 9 segments so that the terminal segments are small. The opposing spine is a small blunt terminal or subterminal tubercle. The terminal claw is markedly longer than the penultimate segment and is rather slender, evenly tapering, and moderately and evenly curved.

The radials are visible only as a narrow line beyond the rim of the centrodorsal and are completely in contact in the interradial angles. The IBr_1 are very short, bandlike, about eight times as broad as long; they are curved slightly downward in the midradial line, and are in contact laterally. The IBr_2 (axillaries) are rhombic, with the distal angle more produced than the proximal, short, about twice as broad as long, with the proximal and distal sides concave; the slightly truncated lateral angles are abruptly swollen and are in lateral contact. There is a rather strongly marked synarthrial tubercle on the articulation between the IBr_1 and IBr_2. The IIBr series are 2 and resemble the IBr series; they are in lateral contact with their neighbors. Both elements of the IIBr series have the outer border swollen, and the axillary has the inner angle also swollen.

The 15 arms are about 90 mm. long. The first brachials are wedge-shaped, about three times as long exteriorly as interiorly. The distal border is slightly incised, and the inner border of adjacent first brachials are united in the proximal two-thirds, diverging at approximately a right angle beyond this point. The second brachials are somewhat larger than the first and are more obliquely wedge-shaped with the outer side longer and the inner side of about the same length. The first syzygial pair (composed of brachials 3+4) is almost oblong, but with the epizygal (fourth brachial) slightly longer interiorly than exteriorly, about three times as broad as long. The next five brachials are slightly wedge-shaped, about four times as broad as the median length, those following soon becoming very obliquely wedge-shaped, almost triangular, about twice as broad as long. After the proximal third of the arms the obliquity of the ends of the brachials gradually diminishes so that in the outer half of the arms the brachials are almost oblong, between three and four times as broad as long, becoming longer terminally.

P_1 is 10 mm. long, with 21 segments, slender, tapering somewhat more rapidly on the first four segments than later. The third segment is about as long as broad, and the eighth and following are about twice as long as broad. P_2 is 13 mm. long, with 19 segments, much stouter than P_1 and tapering evenly from the base to the tip, stiffened, but becoming flexible at the tip; the third segment is slightly longer than broad, the sixth is about twice as long as broad, and the twelfth and following are about three times as long as broad. P_3 is 15 mm. long, with 17 segments, resembling P_2 but proportionately larger and stouter. P_4 is 10 mm. long, with 14 or 15 segments, and resembles P_2. P_5 is 5.5 mm. long, with 12 segments, which become about as long as broad on the fifth and terminally nearly three times as long as broad; it is slightly less broad basally than the preceding pinnules, tapers more rapidly, and is more flexible distally. The pinnules following are of the same length as P_4 and are composed of 14 or 15 segments, of which the third-sixth or -seventh bear on their lower edge a prominent glassy keel, which disappears on the longer and more slender distal pinnules.

The disk is naked.

Locality.—Amboina Bay; about 91 meters; stones and sand; Danish Expedition to the Kei Islands; Dr. Th. Mortensen, March 2, 1922 (1, C. M.).

Remarks.—This species as yet is known only from the type specimen.

Genus LIPAROMETRA A. H. Clark

Comatula (*Alecto*) (part) J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 263.

Comatula (part) Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 207.

Antedon (part) P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, pp. 29, 45, and following authors.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Dichrometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13.

Liparometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 142 (in key), p. 143 (diagnosis; genotype *Himerometra grandis* A. H. Clark, 1908; range; depth; included species); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 98 (in key; range), p. 103 (key to the included species).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 74, 76.—H. L. Clark, Ann. South African Mus., vol. 13, pt. 7, 1923, p. 233 (questions desirability of recognizing the genus).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 84 (syzygies).

Diagnosis.—A genus of Mariametridae in which P_2 and P_3 are elongated, slender, of equal length, and similar except that P_3 has fewer segments than P_2; the division series are in close lateral contact with straight and sharply flattened sides; the cirri are rather short, with not more than 40 segments, of which few or none are longer than broad and the distal are dorsally carinate or bear small dorsal spines, and the dorsal surface of the division series is smooth, without ornamentation.

Geographical range.—Southern Japan from Hirado Strait to Sagami Bay, the Bonin Islands, and southward to the Tonga Islands, northeastern Australia (Port Molle, Queensland), the Moluccas, and the Lesser Sunda Islands.

Bathymetrical range.—From the shoreline down to 69 meters.

Remarks.—The genus *Liparometra* as herein considered includes three species, one of which, *articulata*, seems to be quite distinct, while the other two, *regalis* and *grandis*, are very closely related and may eventually prove to be different forms of the same species, or possibly even identical. All three seem to be rare. As we know them at present their habitats are very widely separated, one occurring in southern Japan, one in the Tonga Islands, and the third in the Australian region, extending to the Moluccas and the Lesser Sunda Islands. But our information in regard to these species is altogether too scanty to permit us to draw any far-reaching conclusions from their apparently anomalous distribution.

History.—The genus *Liparometra* was established by me in 1913, with the genotype *Himerometra grandis* A. H. Clark, 1908, to include Müller's *Comatula* (*Alecto*) *articulata*, Carpenter's *Antedon regalis*, and *Himerometra grandis*. These three species had previously been included in the genus *Dichrometra*.

KEY TO THE SPECIES IN THE GENUS LIPAROMETRA

a^1. Cirri long and rather slender, longest proximal segments from slightly longer than broad to one-third again as long as broad, distal segments with prominent dorsal spines; P_2 and P_3 half again as long as P_1, with 21–26 segments (Queensland to the Moluccas, Lesser Sunda Islands, and Annam; 0–69 meters) ---------- **articulata** (p. 461)

a^2. Cirri shorter and stout, longest proximal segments never longer than broad, distal segments carinate dorsally or with slight dorsal processes; P_2 and P_3 twice as long as P_1, P_2 with 25–30 segments.

  b^1. Less than 30 cirrus segments (Tonga Islands; littoral) ---------- **regalis** (p. 470)

  b^2. More than 30 cirrus segments (southern Japan from Hirado Strait to Sagami Bay, and Bonin Islands; 0–73 meters) ---------- **grandis** (p. 467)

LIPAROMETRA ARTICULATA (J. Müller)

Plate 53. Figures 240–242

Comatula (*Alecto*) *articulata* J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 263 (description; locality unknown).—A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 245 (identity); Crinoids of the Indian Ocean, 1912, p. 30 (same).

Comatula articulata Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 207 (synonymy; description; no locality; Paris Mus.).

Antedon articulata P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*), p. 45 (2 palmars and 2 distichals occur in this species).—Bell, Proc. Zool. Soc. London, 1882, p. 532 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 739 ff. (discussion of Bell's method of formulation and corrected formula).—Bell, Report Zool. Coll. H. M. S. *Alert*, 1884, p. 155 (specific formula), p. 160 (Port Molle).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 226.—Hartlaub, Nova Acta Acad. German,, vol. 58, No. 1, 1891, p. 40 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Mem. Australian Mus., vol 4, pt. 15, 1911, p 714 (=*Dichrometra articulata*), p 716 (credited to Australia by Carpenter); Crinoids of the Indian Ocean, 1912, p. 31 (=*Dichrometra articulata*), p. 34 (identity of Carpenter's reference), p. 148 (B.M., MS.=*Dichrometra tenera* [*gyges*]); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 80 (B.M., MS.=*Lamprometra gyges*).

Antedon reginae Bell, Proc. Zool. Soc. London, 1882, p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula).—Bell, Report Zool. Coll. H. M. S. *Alert*, 1884, p. 155 (specific formula), p. 160 (description; Port Molle), pl. 12, figs. A, *a*.—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, part 60, 1888, p. 225.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1. 1891, p. 39 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier–Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 714 (identity), p. 716 (credited to Australia by Carpenter); Crinoids of the Indian Ocean, 1912, pp. 31, 35 (identity of previous records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 86 (identity).

Himerometra articulata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra reginae A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Dichrometra articulata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Bull. Mus. Hist. Nat., Paris, 1911, No. 4, p. 245 (identity), p. 253 (Moluccas; detailed description of the type); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 440 (East Indian species occurring south to Port Molle), p. 443 (range on the east coast); Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 717 (known to Carpenter from Australia), p. 721 (occurs south to Port Molle), p. 734 (in key), p. 770 (annotated synonymy; characters; Australian records); Crinoids of the Indian Ocean, 1912, pp. 30, 31, 34 (identity of previous records), p. 152 (synonymy; Moluccas; Port Molle; detailed description of the type); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, pp. 223 ff. (detailed account of distribution in Australia).

Dichrometra reginae A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Die Fauna Südwest–Australiens, vol. 3, Lief. 13, 1911, p. 441 (Australian tropical species occurring south to Port Molle), p. 443 (range on the east coast); Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 717 (known to P. H. Carpenter from Australia), p. 721 (occurs south to Port Molle), p. 734 (in key), p. 770 (annotated synonymy; characters; Australian record; description of the type specimen); Crinoids of the Indian Ocean, 1912, pp. 31, 35 (identity of previous records), p. 150 (synonymy; locality); Die Fauna Südwest–Australiens, vol. 4, Lief. 6, 1913, p. 311 (=*D. gyges*).

Liparometra articulata A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 143 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 31 (published references to specimens in the B. M.; locality); A. H. Clark, Unstalked crinoids of the *Siboga* Exped., 1918, p. 103 (in key; range; synonymy; notes; station 49*a*), p. 271 (listed).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 13.

Lamprometra reginae A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Lamprometra moorei Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank; French Indochina), p. 6 (range), p. 12 (locality; notes), p. 14 (relation to *L. palmata*), fig. 3, p. 13.

Diagnostic features.—The cirri are long and rather slender, 30–35 mm. long, with 30–39 segments, of which the longest proximal are from slightly longer than broad to one-third again as long as broad, and the distal, from the eleventh–fourteenth onward, have prominent dorsal spines; P_2 and P_3 are half again as long as P_1, 12–20 mm. long, with 20–26 segments; P_4 is about as long as P_1, or slightly shorter, with 15 segments; the 23–41 arms are 70–125 mm. long.

Description.—The cirri are XVII, 32–36 (the individual cirri counted being 32, 33, 34, and 36), and reach 34 mm. in length. The longest cirrus segments are one-third again as long as broad. Short, though prominent, dorsal spines with long bases are developed from the eleventh or twelfth segment onward.

The radials are scarcely visible. The division series resemble those of *Oxymetra finschii.* They are in close lateral contact and have straight and sharply flattened sides, which are extended laterally somewhat more than in *O. finschii.*

The 40 arms reach a length of 105 mm.

The proximal pinnules are remarkable for their length, but they are very slender and flagellate. P_1 is very weak, though long, and is flagellate distally. P_2 reaches a length half again as great as that of P_1 and has a proportionately more robust base; it reaches almost the same length as P_3. P_3 reaches 20 mm. in length and is the longest of the proximal pinnules, though it is only very slightly longer than P_2; it is composed of 26 segments, which at first are broader than long becoming about as long as broad on the third and about twice as long as broad in the distal portion. P_4 is of about the same length as P_1 and is of the same stoutness at the base. P_5 is of approximately the same length as P_4 and is much weaker. P_6 is smaller than P_5. The following pinnules resemble P_4 and are very short.

Notes.—The preceding description was drawn up by the author from the type specimen in the Paris Museum. Müller described this specimen as follows: The 40 arms are 100–125 mm. long and very regularly divided. The cirri are XX–XXX, 36–40, and cover the centrodorsal with the exception of the middle. Two-thirds of the cirrus segments bear a small spine. There are three radials (that is, the radials are visible and are followed by the two elements of the IBr series), then two ossicles to the next arm division, and beyond this again two ossicles to the succeeding arm division. The axillaries are without a syzygy; they rock to the right and left on the preceding ossicle. The first syzygy is on the third ossicle after the last division (that is, between brachials 3+4), and the distal intersyzygial interval is 12–20 brachials (13-21 muscular articulations). The first pinnule (P_1) is on the second ossicle after the last division. The first pinnule is smaller, the 2 or 3 following large, those succeeding smaller; their segments are cylindrical and not broadened. The color (in alcohol) is gray-brown.

Prof. F. Jeffrey Bell described *Antedon reginae* from Port Molle as follows: The centrodorsal is hidden by the cirri. The cirri are about XXX, 30, about 24 mm. long. The segments are stout and laterally compressed, and about 20 of them are provided with a well-marked spine. The radials are not visible. The IBr_1 are broader than long, and are in lateral contact. The IBr_2 (axillaries) are short, with a very slight backward projection in the middle line. The IIBr series are 2, and the component elements are broad. The IIIBr series are 2. There are 35 arms (the figure shows 38) about 70 mm. long. At first the brachials are fairly regular, though much shorter than broad; later on they become more or less, though never very strikingly, wedge-shaped. If IIIBr series are present there is a syzygy between brachials 3+4. If the arm does not divide a second time there is a syzygy between brachials 5+6. There is a syzygy between brachials 10+11. The distal intersyzygial interval is 10–15 muscular articulations. The first pinnule is shorter than the second, which is of some length, and the third than the fourth; most of the pinnules are very short. The disk is 10 mm. in diameter and is deeply incised. The color is flesh color.

The two specimens from *Siboga* station 49*a* are both much broken. The better may be described as follows: The centrodorsal is low hemispherical, 5 mm. in diameter at the base; the small dorsal pole is strongly concave, 1 mm. in diameter. The cirrus sockets are arranged in three closely crowded irregular rows. The cirri are XXVII, 36–39, from 30 to 35 mm. long. The longest proximal segments are from slightly longer than broad to about one-third again as long as broad. Prominent, though small, dorsal spines are developed from the twelfth-fourteenth (usually the fourteenth) segment onward. The division series are in close lateral contact through rather broad lateral extensions which are straight edged and sharply flattened outwardly. There are 41 arms, all the IIIBr series and one (external) IVBr series being developed. P_1 is 8 mm. long and is composed of 21 segments. It resembles P_a, but the outer segments are not quite so long. P_a is 8 mm. long, with 21 segments, which, gradually increasing in length, become as long as broad on the third and twice as long as broad on the eighth and following. P_2 is 12 mm. long, with 24 segments, and is exactly like P_3. P_3 is very slender, 12 mm. long, with 21 segments, of which the first is very short, the second is nearly as long as broad, the third is slightly longer than broad, and those following slowly increase in length so that the ninth and following are nearly two and one-half times as long as broad. P_4 is 6 mm. long, with 15 segments, not quite so stout basally as P_3 and tapering more rapidly. Though very slender, the proximal pinnules are all slightly stiffened. The disk is completely covered with a pavement of rather small irregular plates. The color is light gray, with very narrow black bands at the articulations; the cirri are white with the distal half light purple ventrally, this increasing in extent distally.

The second specimen has 23 arms. The division series are broad and are sharply flattened laterally. The distal ends of the ossicles of the division series and of the brachials are everted, producing a curiously rough appearance. The disk is completely covered with small rounded calcareous plates.

The specimen from Annam recorded by Dr. Gislén under the name of *Lamprometra moorei* seems to me undoubtedly a representative of this species. Especially characteristic are the three lowest pinnules, which are of approximately the same length and flexible, and the cirri. The division series are broad and sharply flattened as in the smaller specimen from *Siboga* station 49a.

The centrodorsal is discoidal, with the cirri in two closely crowded rows. The cirri are XXX, 22–33, from 14 to 21 mm. long. The longest segment, about the ninth, is one-third again as long as broad. From the ninth or tenth segment onward there is a dorsal longitudinal carination developing into a distinct dorsal spine, which appears a little distally of the middle of the segment. The height of the opposing spine is equal to one-third the width of the penultimate segment. The terminal claw is curved and a little longer than the penultimate segment. The radials are almost concealed. The IBr_1 are six times as broad as long and are in lateral contact. The IBr_2 (axillaries) are twice as broad as long. There is a small synarthrial tubercle on the articulation between the IBr_1 and IBr_2. There are no ventrolateral extensions of the borders of the ossicles of the division series. The arm bases are broad and stout, almost in contact laterally, and very indistinctly pitted dorsolaterally. There are insignificant synarthrial tubercles. One postradial series is broken. The others each bear two IIIBr 2 series, externally developed, so that they have six arms arranged in 2, 1, 1, 2 order. Presumably when complete the specimen had 30 arms, which were about 90 mm. long. P_1 is from 7 to 8.3 mm. long, slender and flexible, with 21–23 segments. P_2 is 9 mm. long with 21 segments. P_3 is 8.5 mm. long with 21 segments. P_4 is about 6 mm. long with 18 segments. The longest segments of P_2 and P_3 are half again as long as broad. These pinnules are coarse and stout, but not stiffened. The disk is naked and incised. The color in alcohol is brownish violet with sparse lighter blotches.

Regarding this specimen Dr. Gislén said:

> This form with its cirrals bearing dorsal spines and a P_1 and P_3 being almost as large as P_2 is rather puzzling. One might perhaps think that it should be a young of *Liparometra articulata*, but there are no ventrolateral extensions of the basal arm-parts. It might be supposed to be a young of *Dichrometra flagellata*, but judging from A. H. Clark (1918 Siboga Exp., p. 107), even rather small specimens have P_3 considerably longer than P_2.
>
> In 1894 Bell described from the Macclesfield Bank a new species of *Antedon*, *A. moorei*. This one was redescribed by A. H. Clark in 1913 and was placed under "unidentified specimens." Nevertheless, when discussing *Lamprometra protectus* (*palmata*) in the same paper, he said that there were no valid characters distinguishing *A. moorei* from a young of *L. protectus*. The specimen described above, which fits very well into the descriptions given of *Ant. moorei*, is however just as large as usual specimens of *L. protectus* (*palmata*). As far as I have seen, the species last mentioned is always provided with slender arm-bases and P_2 is early considerably longer than P_1 and P_3. Besides, in spite of the fact that there may be a dorsal carination in specimens of *L. palmata*, there are no dorsal spines on the cirrals. I think that these characteristics will suffice to keep the two species apart.

Localities.—Port Molle, Queensland; 22–36 meters; H. M. S. *Alert* [Bell, 1882, 1884; P. H. Carpenter, 1883, 1888; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1913, 1918] (1, B. M.).

Port Molle, Queensland; 22–36 meters; H. M. S. *Alert* [Bell, 1884; P. H. Carpenter, 1888; Hartlaub, 1891; A. H. Clark, 1911, 1912, 1918] (1, B. M.).

Moluccas; MM. Quoy and Gaimard, 1829 [J. Müller, 1849; Dujardin and Hupé, 1862; P. H. Carpenter, 1879, 1883, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1913, 1918] (1, P. M.).

Siboga station 49*a;* Sapeh Strait, between Sumbava and Komodo (lat. 8°23′30″ S., long. 119°04′36″ E.); 69 meters; coral and shells; April 14, 1899 [A. H. Clark, 1918] (2, U.S.N.M., E. 387; Amsterdam Mus.).

Cauda, Nha'trang, Annam; Dr. C. Dawydoff [Gislén, 1936].

Geographical range.—From Queensland to the Moluccas, the Lesser Sunda Islands, and Annam.

Bathymetrical range.—From the shoreline down to 69 meters.

History.—This species was first described under the name *Comatula* (*Alecto*) *articulata* by Prof. Johannes Müller in 1849 from a specimen in alcohol in the Paris Museum collected in the Moluccas in 1829 by Jean René Constant Quoy and Joseph Paul Gaimard during the expedition of the *Astrolabe* (formerly the *Coquille*) under the command of Capt. Jules Sébastien César Dumont-d'Urville. The name *Comatula articulata* adopted by Müller was a manuscript name given by Prof. Achille Valenciennes that Müller found with the specimen.

In 1862 Dujardin and Hupé published a translation of Müller's original description, but omitted the color, size, and locality.

Dr. P. H. Carpenter in 1879, after an examination of the type specimen in the Paris Museum, listed *articulata* as a member of the genus *Antedon* as understood by him and mentioned the occurrence of IIBr 2 and IIIBr 2 series.

In 1882 Prof. F. Jeffrey Bell published a specific formula for *Antedon articulata* and also for a new species, which he called *Antedon reginae.* These specific formulae were criticized and emended by Carpenter early in 1883.

In the *Alert* report published in 1884 Professor Bell recorded *Antedon articulata* from Port Molle without comment and also described and figured *Antedon reginae,* which was likewise from Port Molle.

In the *Challenger* report on the comatulids published in 1888 Carpenter criticized Bell's formula for *Antedon articulata* and mentioned the peculiarities of its arm division. In the key to the species of the *Palmata* group *articulata* was paired with the new species *regalis,* both of them having P_2 and P_3 about equal in size. It was separated from *regalis* by having the cirri with 35–40 segments, the later distinctly spiny, whereas in *regalis* there are 25–30 cirrus segments, the later ones with pointed keels, and the lower brachials are flattened. In his description of *Antedon regalis* Carpenter said that this fine specimen (the type specimen) is not unlike *Antedon articulata* but has a smaller number of cirrus segments, with less well defined spines than occur in that species. In fact, the spines are hardly anything more than a small pointed process in the middle of the sharp dorsal keel. The fourth pinnule is relatively smaller and the second syzygy nearer the disk than in the type of *Antedon articulata;* and there are less than 30 arms instead of nearly 40, or even more, as palmar (IIIBr) axillaries are not always developed, and there are no postpalmar (IVBr) series at all.

Carpenter remarked that Bell's *Antedon reginae* was represented by a single specimen with 38 arms. He said that from his experience with *Comanthus parvicirra* he could quite believe it possible that examples may eventually be found in which there are no IIIBr series and so not more than 20 arms. In his key to the species of the *Palmata* group *reginae* was placed under the headings P_a present, two or more axillaries beyond the IBr series, P_2 larger than P_3, the postradial series in close contact laterally, and the cirri spiny. It was distinguished from *gyges* and *palmata* through having P_2 not greatly larger than P_3, no IVBr series, and the first syzygy between brachials 5+6 in arms that arise from a IIBr axillary. In *gyges* and *palmata* P_2 was given as considerably longer than P_3, IVBr series are present, and the first syzygy is always between brachials 3+4. The locality for *reginae* he gave as Queensland.

Hartlaub in 1891 included *articulata* and *reginae* in his key to the species of the *Palmata* group, taking the differential characters from Carpenter's earlier key.

In my first revision of the old genus *Antedon* published in 1907 I referred *articulata* and *reginae* to the new genus *Himerometra,* and in the revision of the family Himerometridae published in 1909 I referred both to the new genus *Dichrometra.*

In a paper on the crinoids of the Paris Museum published in 1911 I redescribed the type specimen of Müller's *Comatula* (*Alecto*) *articulata.*

In my memoir on the recent crinoids of Australia published in 1911 I admitted as valid species both *Dichrometra reginae* and *D. articulata.* In the key to the species of *Dichrometra*, *reginae* (paired with *D. gyges*) was distinguished by having P_2 longer than P_3, *articulata* having P_2 and P_3 about equal in length and 35–40 cirrus segments of which the outer are spiny. Notes on the type specimen of *Antedon reginae* were given; it was said that this species is very close to *articulata* and that further investigation may show that the two are really identical.

In my memoir on the crinoids of the Hamburg Southwest Australian Expedition published in 1911 the ranges of *Dichrometra reginae* and of *D. articulata* are discussed.

In the memoir on the crinoids of the Indian Ocean published in 1912 I listed *Dichrometra reginae* on the basis of the type specimen and gave *D. articulata* from the Moluccas and Port Molle, Queensland, adding the redescription of the type (translated into English) published in 1911. Under *Dichrometra tenera* there was given as a synonym *Antedon articulata* Brit. Mus., MS., a name taken from a specimen of *tenera* (=*gyges*) in the British Museum collection.

In my revision of the family Mariametridae published in 1913 I listed *articulata* under the new genus *Liparometra*, and through an error listed *reginae* under the new genus *Lamprometra*.

In a supplement to my memoir on the crinoids of the Hamburg Southwest Australian Expedition published in 1913 I said, under *Dichrometra gyges*, that "the three supposed species *Dichrometra tenera* (Hartl.), *D. gyges* (Bell) and *D. reginae* (Bell) are in reality the same form," repeating the error made in my revision of the family Mariametridae.

In a paper on the crinoids of the British Museum published in 1913 I definitely placed Bell's *Antedon reginae* as a synonym under *Liparometra articulata* and gave notes on the type specimen.

In my memoir on the unstalked crinoids of the *Siboga* Expedition published in 1918 I placed *Antedon reginae* as a synonym under *Liparometra articulata* and recorded two specimens of the species from station 49*a*. I remarked that it is quite possible that *L. regalis* is really the young of this species. This remark is quite out of place. I intended to say that it is quite possible that *L. regalis* is the young of *L. grandis* (see below).

In 1936 Dr. T. Gislén recorded and gave notes on a specimen from Annam identified as *Lamprometra moorei* and discussed the relationships among *Lamprometra moorei*, *L. palmata*, *Liparometra articulata*, and *Dichrometra flagellata*.

LIPAROMETRA GRANDIS (A. H. Clark)

PLATE 52, FIGURES 238, 239

Himerometra grandis A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 222 (description; Hirado Straits, 40 fathoms).

Dichrometra grandis A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Vid. Medd. Naturh. Foren. København, 1909, p. 172 (locality); Crinoids of the Indian Ocean, 1912, p. 150 (synonymy; locality).

Liparometra grandis A. H. CLARK, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 143 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 31 (comparison with type of *L. regalis*); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 214 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga* Exped., 1918, p. 103 (in key; range).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 74 (Bock's stations 39, 47; notes), p. 182, figs. 85, 86, p. 112; Zool. Bidrag Uppsala, vol. 9, 1924, p. 41 (details of arms), p. 44 (reversion), p. 78 (syzygies), pp. 84, 283; Vid. Medd. Dansk Naturh. Foren., vol. 82, 1927, pp. 2, 22 (Mortensen's station 21; notes), p. 69; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.

Diagnostic features.—The cirri are short and rather stout, about 30 mm. long, with 23–38 (usually 32–36) segments, of which the longest proximal, the eighth–tenth, are about as long as broad, and the distal, from the eleventh onward, are dorsally sharply carinate or bear inconspicuous spines; P_2 and P_3 are nearly or quite twice as long as P_1, 14–20 mm. long, with 15–30 segments, P_3 having fewer segments than P_2; P_4 is about as long as P_1, or slightly shorter; the 26–45 arms are 110–120 mm. long.

Except for certain species of Comasteridae this is the largest of the shallow-water crinoids of Japan. The structure of the cirri and arms is essentially as in *Dichrometra döderleini*, which superficially this species somewhat resembles. It is, however, easily distinguished from that form by the structure of P_2 and P_3, which are of equal length and size, twice as long as P_1, and less stiffened and wiry. The cirri are also proportionately shorter and stouter than those of *D. döderleini.*

Description.—The centrodorsal is thick discoidal, with a rather small polar area bare. The cirrus sockets are arranged in two or three crowded marginal rows.

The cirri are XXIV, 31–38 (usually 32–36), rather stout, 30 mm. in length. The eighth–tenth segments are about as long as broad, the others not so long as broad. From the eleventh onward a sharp dorsal carination is developed on each segment, which may take the form of a small spine. The opposing spine is centrally or subterminally situated, short, not reaching one-half the width of the penultimate segment in height. The terminal claw is somewhat longer than the penultimate segment and is rather abruptly curved.

The division series resemble those of *L. regalis*, but IVBr series are developed exteriorly.

The 45 arms are 110 mm. long and resemble those of *L. regalis.*

P_1 is about 10 mm. long, with 26–30 segments, slender and flagellate. P_2 and P_3 are 20 mm. long, slender, though stiffer than P_1, with, in P_2, 26–30, and in P_3 20–25 segments, of which the third is about as long as broad and those after the fifth are rather over twice as long as broad. P_4 is 9 mm. long, more slender than P_1. The distal pinnules are 10 mm. long. The proximal pinnules are more slender than those of *L. regalis.*

The color in alcohol is reddish brown.

Notes.—Dr. Gislén described the single individual from Mortensen's station 21 as a magnificent specimen. The cirri are XXXVIII, 23–26, from 18 to 29 mm. long. No dorsal spines are developed. The opposing spine is small. There are 28 arms 110 mm. long. P_1 has about 23 segments, P_2 has 18 segments, and P_3 has 15 segments. P_2 and P_3 are of about equal size, about 14 mm. long. P_1 is shorter and more slender.

In the specimen from Bock's station 39, as described by Dr. Gislén, the centrodorsal is discoidal, with the bare dorsal pole 2.5 mm. in diameter. The cirri are arranged in two crowded rows. The cirri are XXIX, the proximal with 31–38 and the distal with 27–30 segments, and are 16 to 24 mm. long. The first–third segments have slightly convex proximal and concave distal margins when seen in lateral view. The fourth and following segments slowly increase in length, becoming about as long as broad on the fifteenth or twentieth. There are no dorsal spines. The opposing spine is small, stout, and blunt, reaching a height equal to one-third the width of the segment bearing it. The terminal claw is short and stout, and is equal in length to the penultimate segment.

The radials are visible as narrow bands beyond the rim of the centrodorsal. The IBr_1 are four times as broad as long and in lateral apposition. The IBr_2 (axillaries) are low pentagonal, three times as broad as long, with concave distal margins. There is a low synarthrial tubercle on the articulation between the elements of the IBr series. The IIBr and IIIBr series are 2, six of the latter being present, all developed externally. The ossicles immediately following each axillary are united interiorly.

The 26 arms are 120 mm. long. The width of the first brachials is 1.6–1.8 mm. The second brachials are rectangular, twice as broad as long, and those following have slightly oblique ends. The distal brachials are discoidal and short, from half again to one-third again as broad as long. The lateral profile of the arms is rather smooth. There are 17 or 18 brachials to each 10 mm. of the arm, or 16 if the syzygial pairs are counted as units. The arms are very close to one another, the interspaces being chiefly between the IBr axillaries to the fourth brachials on the outer side of the postradial series.

The first syzygy is usually between brachials 3+4, but there are often exceptions. The distal intersyzygial interval is 7–12 muscular articulations. Gislén gave in detail the distribution of the syzygies on two arms arising from a IIIBr series and on the adjacent arm arising from the same IIBr axillary. On the external arm from the IIIBr axillary the syzygies are between brachials 8+9, 20+21, and 30+31; on the inner arm arising from the same IIIBr axillary the syzygies are between brachials 8+9, 18+19, and 28+29. On the adjacent arm arising from the same IIBr axillary the syzygies are between brachials 5+6, 21+22, 30+31, 41+42, 52+53, 65+66, 78+79, 90+91, 101+102, and 109+110.

P_1 is 11 mm. long, with 18–21 segments, of which the fourth and following are slender, half again to twice as long as broad, and, like the segments of the pinnules following, smooth. P_2 is 11–18 mm. long, with 19–25 segments. P_3 is 14–16 mm. long (in a single case only 8 mm. long), with 17–20 segments. P_4 is 10–13 mm. long, with 14–16 segments. P_8 is 6.5 mm. long, with 14 segments. The distal pinnules are 8.5–10.5 mm. long, with about 20 segments, which are twice as long as broad. The disk is strongly incised, with the greatest diameter measuring 7 mm. and the least 5 mm. The soft parts do not cover the whole ventral surface of the division series. The color is violet, with lighter and darker transverse bands on the arms.

In one of the two specimens from Bock's station 47 the cirri are XXIII, 14–17, from 5.5 to 7 mm. long. The smallest cirrus has only 11 segments and is 3.5 mm. long. The fifth-seventh cirrus segments are the longest, half again as long as broad. There are no dorsal spines, but the segments are laterally compressed, forming a very weak dorsal keel. The height of the opposing spine equals from one-third to one-fourth the width of the penultimate segment. The radials resemble those in the specimen described immediately above. The IBr_1 are three times as broad as long and have slight lateral prominences. The IBr_2 (axillaries) are one-third again as broad as long and are almost hexagonal because of the posteriorly directed median synarthrial tubercle. The 10 arms are 27 mm. long. The first brachials are interiorly united and are half as broad exteriorly with a convex outer margin—an indistinct lateral prominence. The brachials are smooth. The first syzygy is between brachials 3+4, and the distal intersyzygial interval is 5–7 muscular articulations. P_1 is 4.5–5.5 mm. long and composed of 13–15 segments, of which the longest are two and one-half times as long as broad. P_2 is 5 mm. long, with 13 segments, which are up to three times as long as broad. P_3 is 3 mm. long, with 10 segments. P_4 is 2–3 mm. long, with 9 segments. The pinnules following become longer again. The distal pinnules are 4.5 mm. long, with 15 segments. The disk is incised and is 2.5–4 mm. in diameter. The color is red-brown, with the disk whitish.

Gislén said that the specimen last described might, because of the short P_3, be considered a young individual of *Lamprometra palmata.* It is to be remembered, however, that it is not until a rather advanced stage that young individuals attain the relationships between the lengths of the proximal pinnules that are characteristic of fully grown individuals. For P_1 is first formed, then P_2, and finally P_3. The shortness of P_3 might therefore be ascribed to the youth of the individual.

Gislén pointed out that the relative and absolute lengths of the proximal pinnules in the specimen from Bock's station 39 are very variable.

Localities.—Hirado Strait, southwestern Japan (lat. 33°10′ N., long. 129°18′ E.); 73 meters [A. H. Clark, 1908, 1909, 1912, 1913, 1915, 1918] (1, C. M.).

Dr. Th. Mortensen's Pacific Expedition 1914–1916; station 21*a*; Misaki, Sagami Bay, Japan; about 36 meters; June 1914 [Gislén, 1927].

Dr. Sixten Bock's Expedition to Japan, 1914; station 39; Misaki, Sagami Bay, Japan [Gislén, 1922, 1924].

Dr. Sixten Bock's Expedition to Japan, 1914; station 47; Bonin Islands, east of the Channel; 146 meters; August 1, 1914 [Gislén, 1922, 1924].

Geographical range.—Southern Japan from Hirado Strait to Sagami Bay, and the Bonin Islands.

Bathymetrical range.—Littoral and down to 73 meters at least. Dr. Bock's record of 146 meters refers to the length of dredging cable out, not to the actual depth.

History.—This species was originally described under the name *Himerometra grandis* in 1908 from a specimen in the Copenhagen Museum from Hirado Strait in 40 fathoms. In my revision of the family Himerometridae published in 1909 *grandis* was referred to the new genus *Dichrometra,* and the type specimen was listed as *Dichrometra grandis* later in the same year in a paper on the crinoids in the Copenhagen Museum, and again in 1912 in my memoir on the crinoids of the Indian Ocean.

In my revision of the family Mariametridae published in 1913 *grandis* was transferred to the new genus *Liparometra.* As *Liparometra grandis* it was mentioned as a southern Japanese species in 1915, and it was inserted in the key to the species of *Liparometra* published in the report on the unstalked crinoids of the *Siboga* Expedition in 1918.

In 1922 Dr. Torsten Gislén recorded and described specimens from Dr. Sixten Bock's Expedition to Japan, 1914, stations 39 and 47, and in 1924 he discussed various structural peculiarities of the species. In 1927 he recorded and gave notes upon a specimen that had been obtained by Dr. Th. Mortensen in southern Japan.

LIPAROMETRA REGALIS (P. H. Carpenter)

Antedon regalis P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 237 (description; Tongatabu reefs), pl. 46.—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891,

p. 40 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—Chadwick, *in* Herdman, Report Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 156 (compared with *A. okelli*).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 34 (identity).

Himerometra regalis A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 222 (comparison with *H. grandis*).

Dichrometra regalis A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Crinoids of the Indian Ocean, 1912, p. 34 (identity), p. 150 (synonymy; Tonga Islands).

Liparometra regalis A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 143 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 31 (published references to the specimen in the B. M.; locality; comparison with *L. grandis*); Unstalked crinoids of the *Siboga* Exped., 1918, p. 103 (in key; range).

Diagnostic features.—The cirri are rather short and stout, with 25–30 segments, of which the longest proximal are not longer than broad and the distal are dorsally carinate; P_2 and P_3 are about twice as long as P_1, 15 mm. long, with about 30 segments; P_4 is about as long as P_1, with 15 segments; the 27 arms are about 150 mm. long.

Description.—The centrodorsal is a thick disk.

The cirri are about XL, 25–30. The middle and outer segments are somewhat compressed laterally, developing a bluntly pointed keel, which passes into the dorsal spine of the penultimate.

The anterolateral angles of the radials are just visible. The IBr_1 are short and are partially united laterally. The IBr_2 (axillaries) are broad, more than twice the length of the IBr_1, and are almost triangular. The postradial series may divide three times. All the division series are 2. The first few ossicles above the IBr axillary on the outer sides of the postradial series have their outer edges curved and folded, while the lower brachials, both of the inner and of the outer arms, have their apposed sides flattened against one another.

The 27 arms are about 150 mm. long. They are long and tapering and consist of about 180 brachials, of which the lower ones are discoidal and their successors are shortly triangular, becoming more quadrate in the middle of the arm and in the terminal third more nearly square, elongating slightly toward the arm tip.

The first syzygy is between brachials 3+4, the second from between brachials 16+17 to between brachials 19+20, and the distal intersyzygial interval is 9 to 19 muscular articulations.

On the outer side of the postradial series P_1 may reach 8 mm. in length, with 27 segments, but on the inner arms it is generally somewhat smaller. P_a is about equal to P_1. P_2 is also rather larger on the outer than on the inner arms, reaching 15 mm. in length and consisting of about 30 segments, of which the first third are moderately stout and the remainder more slender and somewhat elongated. The pinnules of the next three brachials (P_b, P_3, and P_c) are of nearly equal size, but P_4 and P_d are only about half their length, with 15 segments, and the pinnules of the next pair are still smaller.

The disk is 20 mm. in diameter and is naked and much incised. Sacculi are abundant along the sides of the pinnule ambulacra.

The color in alcohol is dark purple, with greenish white spots on the disk.

Notes.—The preceding description is adapted from the original description of Carpenter. In 1910 I examined the type specimen in the British Museum. This species is much like the Japanese *Liparometra grandis*, but it is a smaller and in every way more delicate form. There are no spines on the distal cirrus segments. The figure given of it in the *Challenger* report is excellent.

It is possible that *Liparometra grandis* may turn out to be merely the fully developed form of the present species.

Carpenter said that the fine specimen on which this species is based is not unlike *Antedon* (*Liparometra*) *articulata*, but it has a smaller number of cirrus segments which have less well defined dorsal spines—in fact the spines are hardly anything more than a small pointed process in the middle of the sharp dorsal keel. P_4 is relatively smaller, and the second syzygy is nearer the disk than in the type specimen of *articulata*, and there are less than 30 arms instead of nearly 40, or even more, as IIIBr axillaries are not always developed, and there are no IVBr series at all.

Locality.—Tongatabu Island, in the southern portion of the Tonga archipelago; reefs; *Challenger*, 1874 [P. H. Carpenter, 1888; Hartlaub, 1891; Chadwick, 1904; A. H. Clark, 1907, 1908, 1909, 1912, 1913, 1918] (1, B.M.).

History.—This species was first described under the name *Antedon regalis* by P. H. Carpenter in 1888 from a single specimen that had been collected by the *Challenger* on the reefs at Tongatabu, the largest of the Tonga Islands, in 1874.

Hartlaub in 1891 inserted *regalis* in his key to the species of the *Palmata* group, using the differential characters that were employed by Carpenter in his key to the species of the same group in 1888.

Chadwick in 1904 compared *regalis* with his new species *Antedon okelli* (= *Lamprometra palmata*), and in 1908 I compared it with my new species *Himerometra* (*Liparometra*) *grandis*.

In my first revision of the old genus *Antedon* published in 1907, *regalis* was assigned to the new genus *Himerometra*, and in my revision of the family Himerometridae published in 1909 it was transferred to the new genus *Dichrometra*.

In my memoir on the crinoids of the Indian Ocean published in 1912 I listed *Dichrometra regalis* and gave the synonymy and habitat.

In my revision of the family Mariametridae published in 1913 I placed *regalis* in the new genus *Liparometra*.

In a paper on the crinoids of the British Museum published in 1913 I gave notes on the type specimen, and in a memoir on the unstalked crinoids collected by the *Siboga* published in 1918 I inserted *regalis* in the key to the species of the genus *Liparometra*.

Genus LAMPROMETRA A. H. Clark

Comatula (part) Leuckart, Zeitschr. für organ. Physik, vol. 3, Heft 4, 1833, p. 387.

Alecto (part) J. Müller, Monatsber. preuss. Akad. Wiss., 1841, p. 185.

Comatula (*Alecto*) (part) J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 261.

Antedon (part) Lütken, Mus. Godeffroy Cat., vol. 5, 1874, p. 190, and following authors.

Actinometra (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 60.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Dichrometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13.

Lamprometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 142 (in key), p. 143 (diagnosis; genotype *Antedon imparipinna* P. H. Carpenter, 1882; range; depth; included forms); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 98 (in key; range), p. 100 (key to the included species).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 76.—H. L. Clark, Ann. South African Mus., vol. 13, pt. 7, 1923, p. 233 (questions desirability of recognizing the genus).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 150 (compared with *Solanocrinus costatus*); Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 47.

Diagnosis.—A genus of Mariametridae in which P_2 is the longest pinnule, usually much longer than P_3, and tapers gradually to a slender and delicate tip; the division series are usually in very close lateral contact with more or less broadly and sharply flattened sides, more rarely just in contact with the sides slightly or not at all flattened; the cirri are rather short, with not more than 30 segments, of which the outer are carinate, rarely more or less spinous, dorsally; and the dorsal surface of the division series is smooth, without ornamentation.

Geographical range.—From Hongkong and the Philippines to the Caroline, Marshall, and Hawaiian Islands, Fiji, the Tonga Islands, New Caledonia, the Solomon Islands, northern Australia south to Cape Hillsborough, Queensland, and the Abrolhos Islands and possibly Perth, Western Australia, and westward to the eastern coast of Africa from the Red Sea south to Dar-es-Salaam, Tanganyika Territory.

Bathymetrical range.—From the shoreline down to 51 (?54) meters. The species are essentially littoral reef-inhabiting forms.

Remarks.—The genus *Lamprometra* as considered herein includes two species, one, *L. klunzingeri*, characterized by slender proximal pinnules of which the basal segments are either not at all or only very slightly carinate, occurring from the Red Sea to Muscat and southward possibly to Dar-es-Salaam, and the other, *L. palmata*, with one or more of the proximal pinnules either enlarged or strongly carinate, occurring from Baluchistan eastward to northern Australia, Polynesia, the Philippines, and Hongkong.

It is quite possible that *L. klunzingeri* is simply the western form of *L. palmata*, although on the basis of the material examined it appears to be quite distinct, the entire or almost complete absence of carination on the basal segments of the proximal pinnules being diagnostic.

Generally speaking, among the Mariametrida in forms in which the lower pinnules are carinate the carination disappears if the lower pinnules are enlarged, so that strong carination or enlargement of the lower pinnules are alternative conditions. This is well seen in the genus *Himerometra* in which *H. persica* and *H. bartschi* have slender and strongly carinate proximal pinnules, and the other species very stout proximal pinnules, which are not carinate basally.

It seems reasonable, therefore, to consider *L. klunzingeri*, with noncarinate slender proximal pinnules, as distinct from *L. palmata*, of which one form (*palmata*) has P_2 much enlarged and the other (*gyges*) has P_2 slender and strongly carinate basally.

Lamprometra palmata is always easily distinguished from all other comatulids, but at the same time it is the most variable species known, and scarcely any two individuals are quite alike. The cirri are usually carinate dorsally on the distal segments, but these may be rounded dorsally, or they may bear more or less conspicuous spines. The earlier segments may be broader than long, like the distal, or as long as, or even longer than, broad, and markedly longer than the distal segments. The postradial series may be in close lateral apposition and broadly and sharply flattened laterally, or quite separated without any trace of lateral flattening, or in any intermediate condition. P_2 is always the longest or the stoutest pinnule, but it varies from very stout and greatly elongated to slender and scarcely or even not at all larger than P_3 or P_1, and it may be scarcely or even not at all longer than one or the other of these pinnules. The proximal pinnules may be of approximately equal size on all the arms, or much larger and longer on the outermost arms following a IBr axillary than on the other arms, or they may be enlarged, or elongated, or both, on the outermost arms following each IIBr axillary, those on the outermost side of the postradial series being more or less larger than those adjoining the midradial line.

In the following pages the form of *L. palmata* with very slender lower pinnules (*gyges*) is recognized as distinct for the reason that it has a more or less distinctive geographical range, which, however, broadly overlaps the range of the typical form (*palmata*). Intergradation between the two forms is complete, and they are often found together.

The excessive variation of *L. palmata* is probably correlated with the highly diversified conditions in its strictly littoral habitat, and there is no reason to assume that characters which in this species are very variable are necessarily similarly variable in other more or less closely related species.

History.—In a revision of the family Mariametridae published in 1913 I established the genus *Lamprometra* with *Antedon imparipinna* P. H. Carpenter, 1882, as the genotype. The following nominal species were assigned to the new genus: *aequipinna, amboinensis, brevicuneata, conjungens, dividua, gyges, heliaster, imparipinna, klunzingeri, laevicirra, lepida, leucomelas, occulta, okelli, palmata, polyactinis, protectus, reginae, scita, similis, subtilis,* and *tenera.* Previously these forms had been included in the genus *Dichrometra* established in 1909.

The genus *Lamprometra* is herein considered as including these same forms grouped in two species, *L. klunzingeri* and *L. palmata*, the latter with two varieties, *L. p. palmata* and *L. p. gyges.*

KEY TO THE SPECIES AND FORMS IN THE GENUS LAMPROMETRA

a^1. P_2, and sometimes also P_3, markedly stouter than the other proximal pinnules (Hongkong and Philippines to Caroline, Marshall, and Hawaiian Islands, Fiji, Tonga Islands, New Caledonia, Solomon Islands, and Torres Strait, and westward to Baluchistan; 0–51 [?54] meters)
palmata palmata (p. 474)

a^2. All the proximal pinnules slender.
  b^1. Basal segments of proximal pinnules strongly carinate (Marshall Islands, Samoa, and Fiji, to northern Australia, south to Cape Hillsborough, Queensland, and Abrolhos Islands and possibly Perth, Western Australia, and westward to Kabaëna Island; 0–35 meters)
palmata gyges (p. 517)
  b^2. Basal segments of proximal pinnules not at all, or only very slightly carinate (Red Sea eastward to Muscat and southward possibly to Zanzibar or Dar-es-Salaam; littoral).
klunzingeri (p. 527)

LAMPROMETRA PALMATA PALMATA (J. Müller)

PLATE 53, FIGURES 243–246; PLATE 54, FIGURES 248–252; PLATE 55, FIGURE 257

[See also vol. 1, pt. 1, fig. 259 (centrodorsal), p. 255; fig. 477 (radial pentagon), p. 363; pt. 2, figs. 49, 50 (radial pentagon), p. 26; fig. 250 (arm), p. 199; figs. 472, 473 (pinnule tip), p. 269; fig. 720 (disk), p. 346.]

?*Caput-Medusae cinereum* LINCK, De stellis marinis, 1733, p. 57, pl. 21, No. 33.—BRUGIÈRE, Encyclopédie méthodique, 1792, pl. 125, figs. 1, 2 (copied from Linck).—J. MÜLLER, Monatsb. preuss. Akad. Wiss., 1841, p. 185 (identified with a query as *Alecto palmata*, sp. nov.); Archiv für

Naturg., 1841, vol. 1, p. 144 (same); Abh. preuss. Akad. Wiss., 1847 (1849), p. 261 (same).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 2 (history; an *Antedon*).—A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 1, 279 (remarks; a species of *Dichrometra*).

?*Asterias multiradiata* Linnaeus, Systema naturae, ed. 10, vol. 1, 1758, p. 663 (in part; reference to Linck).

Alecto palmata J. Müller, Monatsb. preuss. Akad. Wiss., 1841, p. 185 (description; India); Archiv für Naturg., 1841, vol. 1, p. 144 (same); Abh. preuss. Akad. Wiss., 1841 (1843), p. 192 (structure).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641.

Comatula (*Alecto*) *palmata* J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 261 (Indian Ocean; in Anatomical Mus., Berlin, through Eschricht; from India; in the Paris Mus. from Sambuangan through Hombron [*Astrolabe*]; other localities refer to *L. klunzingeri*).

Comatula dividua Dujardin and Hupé, Histoire naturelle des zoophytes, Èchinodèrmes, 1862, p. 208 (*nomen nudum*).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 143 (=*Dichrometra protectus* [*L. palmata*]).

Comatula polyactinia Dujardin and Hupé, Histoire naturelle des zoophytes, Èchinodèrmes, 1862, p. 208 (*nomen nudum*).

Antedon protectus Lütken, Mus. Godeffroy Cat., vol. 5, 1874, p. 190 (in part; Tonga Island; *nomen nudum*).—A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 31 (Brit. Mus., MS.; Tonga).

Antedon palmata P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 23 (in part; arm structure), p. 29 (in part; listed as an *Antedon*), p. 45 (2 palmars on 2 distichals occur in this species).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 733 ff. (discussion of Bell's method of formulation and corrected formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 35 (in part), 44 (in part), 54 (in part), 55 (in part), 208 (in part), 213 (in part), 366 (in part), 379 (Ceylon, but not Red Sea).—Bell, Proc. Zool. Soc. London, 1888, p. 384 (Tuticorin, Madras), p. 387 (occurs in the Bay of Bengal).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 51 (Singapore), p. 52 (Tonga Islands; Ceylon), p. 113 (in Göttingen Mus.).—Thurston, Madras Gov. Mus. Bull. 1, 1894, p. 28 (Tuticorin; in dense clusters in crevices hollowed out of coral blocks), p. 53 (East Cheval Par; taken by divers); Bull. 2, 1894, p. 106 (Gulf of Manaar; littoral), p. 114 (Pamban and Tuticorin; in crevices of coral or on gorgoniae).—Chadwick, *in* Herdman, Report Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (in part; listed).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 385 (identity of Hartlaub's records); Crinoids of the Indian Ocean, 1912, pp. 34, 37, 40, 41 (identity of previous records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 85 (of Bell, 1888, and Thurston, 1894=*Stephanometra indica*+*L. palmata*; of Bell, 1902=*Himerometra sol*).

Antedon dividua P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*).

Antedon polyactinis P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*).

Antedon brevicuneata P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 187 (description; Amboina).—Bell, Proc. Zool. Soc. London, 1882, p. 532 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 54, 223, 226, 235–237, 366, 379.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 11 (collected by Brock at Amboina), p. 15 (not rare at Amboina), p. 40 (in key), p. 68 (synonymy; includes *similis* P. H. Carpenter and *amboinensis* Hartlaub; Amboina; Mortlock Island; specimens from Amboina described), p. 113 (in Göttingen Mus.), pl. 3, fig. 31, pl. 4, fig. 39.—Chadwick, *in* Herdman, Report Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 156 (compared with *A. okelli*).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 176 (=*Dichrometra protectus* [*L. palmata*]; reexamination of the type); Crinoids of the Indian Ocean, 1912, pp. 34, 37 (identity).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (listed), p. 409 (Ebon, Marshall Islands; Oahu, Sandwich Islands; notes).

Antedon laevicirra P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 189 (description; Aru Islands.—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 54, 225, 366, 379.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 37 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 176 (reexamination of the type; identity); Crinoids of the Indian Ocean, 1912, p. 34 (identity).

Antedon protecta P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 192.—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 53, 54, 91, 225, 234, 237, 366, 379 (discussion; characters; Fiji; Tonga); Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 312 (compared with *A. conjungens*).—Hartlaub, Nachr. Ges. Göttingen, May 1890, pp. 170, 180 (description; Tonga); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 65 (synonym of *A. imparipinna*).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 34 (identity).

Antedon aequipinna P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 504 (description; locality unknown); Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 55, 225, 227, 379.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Smithsonian Misc. Coll., Vol. 60, No. 10, 1912, p. 2 (=*Dichrometra protectus* [*L. palmata*]); Crinoids of the Indian Ocean, 1912, p. 34 (same); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 31 (Brit. Mus., MS.; Fiji).

Antedon imparipinna P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 505 (description; locality unknown); Proc. Zool. Soc. London, 1882 (1883), p. 746 (specific formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 54, 225, 366, 379.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 11 (collected by Brock at Amboina), p. 15 (not rare at Amboina), pp. 38, 39 (in key), p. 62 (synonymy; includes *protecta*, *aequipinna*, and *conjungens;* Amboina; Tonga Island; Batjan; Hongkong; New Guinea; Ovalau; detailed description of the specimens from Amboina and notes on the others), p. 113 (in Göttingen Mus.), pl. 4, figs. 40, 41, 43.—Koehler, Rev. Suisse zool., vol. 3, 1895, p. 288 (Bay of Amboina; notes).—Döderlein, Denkschr. med.-naturw. Ges. Jena, ser. 8, vol. 5, 1898, p. 477 (Amboina).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 720 (of Döderlein, 1898=*Dichrometra protectus* [*L. palmata*]); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 385 (of Hartlaub, 1891, identity); Crinoids of the Indian Ocean, 1912, pp. 34, 37, 39, 41 (identity of previous records).

Antedon similis von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, pp. 4, 6 (station 174; myzostomes).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 235 (description; station 174, B, C or D; remarks), pl. 47, figs. 1–3.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 40 (in key), p. 71 (characters; synonym of *brevicuncata*).—Chadwick, Report Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 156 (compared with *A. okelli*).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed); pl. 12, fig. 2 (from Carpenter).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 35 (identity).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (listed); p. 410 (Oahu, Sandwich Islands; notes).

Antedon occulta von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, pp. 4, 6 (station 174; myzostomes).—P. H. Carpenter, *Challenger* reports, Zoology, vol. 26, pt. 60, 1888, p. 236 (description; station 174, B, C or D; remarks), pl. 48, figs. 1, 2, pl. 49, figs. 3, 4.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 40 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 34 (identity).

Actinometra conjungens P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 60.

Antedon conjungens P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 233 (description; Zebu reefs; remarks), pl. 45, fig. 1.—Bell, Proc. Zool. Soc. London, 1888, p. 389, footnote [5] (collected by Dr. Anderson at Mergui).—P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 21, 1889, p. 305 (specific formula), p. 311 (King Island; characters of the specimen), pl. 27, figs. 1, 2.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 34, 36 (identity of previous records).

Antedon sp. (*Palmata* group) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 224 (Sandwich Islands; Ceylon).

Antedon lepida Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 176 (description; Tonga Islands).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 49 (in synonymy of *A. palmata*).—A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity).

Antedon amboinensis Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 181 (description; Amboina).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 69, footnote (discussion; synonym of *brevicuneata*).

Antedon moorei Bell, Proc. Zool. Soc. London, 1894, p. 396 (Macclesfield Bank, 13 fathoms), p. 400 (in key), p. 401 (description; a member of the *Spinifera* group).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 484 (unrecognizable from the description; probably a member of the *Palmata* group).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 309 (in the *Spinifera* group; history; discussion), p. 310 (insufficiently described).—A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 38, 287 (redescribed; is an immature specimen of *similis*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 69 (redescription).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank), p. 14 (history).

Antedon subtilis Hartlaub, Bull. Mus. Comp. Zool., vol. 27, 1895, p. 151 (description; Gaspar Strait; comparison with *A. klunzingeri*).

Antedon indica (part) Bell, Willey's Zool. Results, pt. 2, 1899, p. 135 (Blanche Bay, New Britain).

Antedon okelli Chadwick, *in* Herdman, Report Ceylon Pearl Oyster Fisheries, pt. 2, Suppl. Rep. 11, 1904, p. 153 (occurs at Ceylon), p. 155 (stations I, II, LVII; description and comparisons), plate, figs. 3–5.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 40 (identity).

Himerometra brevicuneata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra imparipinna A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra laevicirra A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra occulta A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra okelli A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra subtilis A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Antedon protectus A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 489 (status of the name); Vid. Medd. Naturh. Foren. København, 1909, p. 117 (identity).

Himerometra protectus A. H. Clark, Smithsonian Misc. Coll., vol. 52, 1908, p. 220 (Simonor, Tataan Islands; Pangasinan Island; also Philippine Islands, with no more definite data).

Dichrometra brevicuneata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed).

Dichrometra occulta A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Crinoids of the Indian Ocean, 1912, p. 34 (identity), p. 150 (synonymy; ?Fiji).

Dichrometra okelli A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed).

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Dichrometra subtilis A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Crinoids of the Indian Ocean, 1912, p. 149 (synonymy; Gaspard Strait).

Dichrometra palmata A. H. Clark, Zool. Anz., vol. 34, 1909, p. 367 (Salawatti); Crinoids of the Indian Ocean, 1912, p. 148 (Gwada, Baluchistan; Snod Island; ?Celebes; Ceylon; Java; Singapore; Bougainville Island; Tonga).—Reichensperger, Abh. Senck. naturf. Ges., vol. 35, Heft 1, 1913, p. 83 (Amboina; Ceylon), p. 103 (characters of the specimens).—H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 93 (occurs at Ceylon; from A. H. Clark).

Dichrometra laevicirra A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 186 (Aru Islands; detailed redescription of the type; comparison with *D. protectus;* possibly a synonym of the latter); Crinoids of the Indian Ocean, 1912, p. 147 (synonymy; description of the type; comparisons).

Comatula dividuus A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 254 (Java; M. Philibert; identified).

Comatula polyactinis A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 246 (=?), p. 254 (Samboanga, Hombron and Jacquinot, 1841; identified; this is the specimen mentioned by Müller, 1849); Crinoids of the Indian Ocean, 1912, p. 143 (of Dujardin and Hupé = *Dichrometra protectus*), p. 152 (= *D. articulata* [error]).

Dichrometra similis A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 35 (= *Antedon similis* P. H. Carpenter, 1888), p. 38 (= *A. moorei* Bell, 1894), p. 147 (synonymy; locality; probably same as *D. protectus*).

Lamprometra aequipinna A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Lamprometra amboinensis A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Lamprometra brevicuneata A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Lamprometra conjungens A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Lamprometra dividua A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

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Lamprometra protecta H. L. Clark, The Echinoderm Fauna of Torres Strait, 1921, p. 23 (Ceylon; Fiji; Philippines; discussion), pp. 192 and following (range); Rec. South Australian Mus., vol. 3, 1928, p. 368 ("northern coast of Australia"; notes).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641 (use of the name).

Lamprometra palmata A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641 (Muhlos, Maldives; Flying-fish Cove, Christmas Island; Macclesfield Bank, 10–13, and 13 fathoms); Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed; use of the name), p. 557 (localities; notes; parasitic *Melanella*); Proc. Biol. Soc. Washington, vol. 47, 1934, p. 11 (Singapore; Christmas Island); Temminckia, vol. 1, 1936, p. 303 (Maratoea; Paleleh; Sipankot; Sissie; Wotap; Obi latoe; Beo; Laha; Lembeh Strait; notes).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 2 (Pulo Condor), p. 4 (Macclesfield Bank; French Indochina), p. 5 (range), p. 12 (localities; notes), p. 14 (relation to *L. moorei*).—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 100 (range), p. 103.

Diagnostic features.—P_2 is markedly stouter than the other proximal pinnules. Though it is exceedingly variable in all its characters the superior length and stoutness of P_2 make *Lamprometra palmata palmata* an easy form to recognize, when typically developed. It intergrades completely with *L. p. gyges.*

Description.—The centrodorsal varies from a thin disk 3 mm. in diameter to a thick disk with more or less strongly sloping sides 6 mm. in diameter. It is usually large, 4–6 mm. in diameter, thick discoidal, with moderately sloping sides and with the cirri arranged in two or two and a partial third, rarely a single, irregular marginal rows. The bare dorsal pole is usually more or less strongly convex, more rarely flat or even slightly concave, and measures 2.5 to 4 mm. in diameter.

The cirri are XVIII–XLVI (usually about XXX), 20–30 (usually 22–25), 12 to 25 (usually 15 to 20) mm. long. They vary from slender to stout. The segments may be all subequal and all broader than long, or those from the fourth-sixth to the ninth-twelfth may be longer than those in the distal half, as long as broad or even up to one-third again as long as broad. The segments in the distal half of the cirri are more or less strongly compressed laterally and are usually more or less sharply carinate dorsally, rarely bearing slightly or moderately developed dorsal spines. In lateral view the distal half of the cirri is usually, but not always, slightly broader than the proximal half. The opposing spine is moderate or small in size.

The radials are either entirely concealed by the centrodorsal or their anterolateral angles are more or less extensively visible in the interradial angles of the calyx. The

IBr_1 are usually entirely visible, but they may be partly, or even almost completely, concealed by the centrodorsal. They are short and are usually entirely or partially united, though sometimes entirely free, laterally. The IBr_2 (axillaries) are short and broadly pentagonal; rarely they are partially concealed by the centrodorsal. The IIBr series are usually all present, and usually the outer IIIBr series on each postradial series are developed, giving six arms to each postradial series arranged in 2, 1, 1, 2 order; but not infrequently all the IIIBr series are developed and one or more IVBr series may occur, so that there are eight or more arms on some, most, or all the postradial series. The axillaries are often somewhat asymmetrical. The postradial series are usually in fairly close lateral contact. They may be in very close apposition, with produced and thickened margins and very strongly flattened against each other, or they may be only in partial contact or even slightly separated from each other. The outer border of the postradial series is occasionally crenate. The division series and arm bases are usually rather strongly convex dorsally. More or less developed, though always low and broad, synarthrial and articular tubercles are usually present, giving the proximal portion of the animal a characteristically rugose appearance; but not infrequently these are obsolete or even entirely absent.

The arms are 23–51 (usually 30–40) in number, 40 to 125 (usually between 55 and 80) mm. long. They may be short and composed of only about 100 brachials or elongated with about 170 brachials. Usually they are of moderate length and consist of about 150 brachials. The dorsal surface of the arms is usually more or less rugose basally but otherwise smooth and is often smooth throughout. The arms may taper gradually from the base to the tip, or they may increase slightly in width up to about the fourteenth brachial, thence tapering distally. The first brachials are wedge-shaped or almost rhomboidal, slightly longer externally than internally, and closely united internally. The second brachials are shorter than the first and are nearly oblong, though slightly longer externally than internally. The first syzygial pair (composed of brachials 3+4) is commonly about as long as broad, though often broader than long. The next four to six brachials are short and nearly oblong, and those following are triangular or very obliquely wedge-shaped, nearly or quite twice as broad as long, later becoming more bluntly wedge-shaped, and terminally oblong, remaining broader than long until near the arm tips. Low and more or less obscure articular tubercles are usually, though not always present on the arm bases.

Syzygies occur between brachials 3+4, again from between brachials 13+14 to between brachials 31+32 (most commonly somewhere between the fifteenth and twentieth brachials), and distally at intervals of 6 to 20 (usually 8 to 13) muscular articulations.

The lower pinnules may be approximately equal on all the arms, but usually those on the outer side of the outermost arms of each postradial series, especially P_2, are more or less, and often greatly, larger than the others. Frequently the lower pinnules on the outer side of the outermost arms arising from each IIBr axillary are enlarged, those on the outermost side of the postradial series bearing the two IIBr series being more enlarged than those adjoining the midradial line. The relative amount of enlargement of the lower pinnules on the outer arms arising from a IBr or IIBr axillary may vary greatly even in specimens of the same size from a single locality. Sometimes the lower pinnules on the outer arms arising from a IBr or IIBr axillary are little or not at all stouter than those on the inner arms, but are much elongated. Occasionally all the lower pinnules are slender, *Lamprometra palmata palmata* intergrading imperceptibly into *L. p. gyges.* P_2 is usually abruptly longer and stouter than the other pinnules, but occasionally P_3 is nearly as long and almost as much enlarged, and sometimes P_1 may be nearly as long though always more slender.

P_1 varies greatly in size. It may be small or nearly or even quite as long as P_2. It is usually one-half to two-thirds as long as P_2, and is not so stout, tapering more rapidly at the base. On the outer arms it varies from 7 to 12 mm. in length, being usually 9 to 12 mm. long, and is composed of 12–35 (usually 20–25) segments. The basal segments are rather broad, but the pinnule tapers rapidly in its proximal portion and is slender in the distal two-thirds. The proximal segments are broader than long, and the distal are usually not greatly longer than broad. The pinnule is more or less cylindrical and is usually somewhat stiffened, but becomes flagellate at the tip. P_a may resemble P_1, or it may be much smaller. P_2 is the longest and stoutest pinnule on the arm and is usually much longer and stouter than either P_1 or P_3; but it may be scarcely longer than these pinnules and scarcely stouter than P_3. Occasionally it is slender. It is more or less strongly stiffened, though tapering to a delicate and flagellate tip. It is usually more or less, and often strongly, recurved toward the arm tip, but it may be straight and almost spinelike. It varies from 9 to 18 mm. in length on the outermost arms of the postradial series, being usually between 10 and 15 mm. long. It is composed of 16–40 (most commonly 25–30) segments, which are usually mostly about as long as broad. It may be as much as three times as long as the corresponding pinnule on the inner arms, though it is usually about half again as long and may be of practically the same size. The component segments are smooth and cylindrical, the earlier broader than long and the outermost about twice as long as broad. P_b is similar to P_2 but is more or less smaller.

P_3 is sometimes nearly equal to P_2 in length and stoutness, but it is usually considerably shorter and less stout. It may be not so much as half as long as P_2. It varies from 6 to 10 mm. in length and is composed of 8 to 20 segments.

P_4 may be similar to P_3 and of almost the same length, or it may be a good deal shorter, only one-quarter as long as P_2, with a smaller number of segments, sometimes as few as 7 or 8. It is occasionally the smallest pinnule on the arm.

P_5 and P_6 are 3 to 5 mm. long. The pinnules following gradually increase in length, the distal pinnules being 5 to 8 mm. long and consisting of 19 or 20 smooth segments.

The disk is 10 to 20 mm. in diameter and is naked and more or less deeply, often very deeply, incised. Sacculi are abundant and usually closely set along the sides of the pinnule ambulacra.

Notes.—The specimen from the Macclesfield Bank was described by Prof. F. Jeffrey Bell as the representative of a new species, which he called *Antedon moorei.* He said:

> This species is probably most nearly allied to *A.* [*Parametra*] *compressa*, P. H. C., but it has only faint spinous processes on the cirrus-joints. Cirri 25 to 30, with 25 joints. Centrodorsal bare in the middle. No syzygies on radials, distichals or palmars. There may be post-palmars. The third

brachial syzygial; arm-joints iii–vi, squarish, the succeeding triangular, and the more distal gradually overlapping.

Colour purplish, with the free ends of the arms white.

The single specimen is a good deal broken, but it is interesting as belonging to a series of the [*Spinifera*] group of which Dr. Carpenter knew only one type.

In the type specimen, which I examined in London in 1910, the cirri are XVIII, 21–25, 17 mm. long. The longest proximal cirrus segments are about one-third again as long as broad; the 13 outermost segments are slightly broader than long and bear moderately developed dorsal spines. The 32 arms are 60 mm. long. The IIBr and IIIBr series are 2 and are in close lateral apposition. The lateral borders of the elements of the division series appear to be somewhat produced. P_2 is the longest and largest pinnule and is about half again as long as P_1. It is enlarged, long, and slightly stiffened, and tapers evenly to a delicate and flagellate tip exactly as in *L. palmata.* It is composed of 16–21 segments, which become about as long as broad on the third and twice as long as broad distally. It is considerably larger on the outer arms arising from each IBr axillary than on the inner. P_1 is similar to P_2 but only two-thirds as long and not so stout, and it tapers somewhat more rapidly. P_3 is about as long as P_1 but is slightly stouter and tapers less rapidly, thus more nearly resembling P_2; it is composed of 16 segments. The following pinnules are small and weak. This is an immature specimen of the form called *similis* (see page 485) by Carpenter.

In the young specimen from Annam, according to Gislén, the cirri are 14–15 mm. long, with 19–23 segments. There are 28 arms. P_2 is by far the largest pinnule.

In the specimen from Cochinchina, which is larger and has broader arm bases, the diameter of the centrodorsal is 5 mm. The cirri are all broken. There are 40 arms, with one IVBr series present. P_2 is much longer than P_1 or P_3.

The two specimens in the *Challenger* collection from the Cebu reefs were described by Carpenter as a new species under the name of *Antedon conjungens.* According to him the centrodorsal is a thick slightly convex disk bearing marginal cirri. The cirri are about XXVIII, 20–30. The segments are uniform, the later ones somewhat compressed laterally with a sharp dorsal keel that passes into the opposing spine. The radials are concealed. The IBr_1 are broadly hexagonal and are partly united laterally. The IBr_2 (axillaries) are pentagonal. The postradial series, which are laterally free from the IBr_1 onward, divide three and occasionally four times. All the division series are 2. The outer sides of the elements of the IIBr and IIIBr series are much produced toward the ventral surface so that each of the five divisions of the disk, as seen from the ventral side, has more or less distinct bony margins. The arms are rather over 40 in number, 100 mm. long, and composed of about 150 brachials of which the first few are discoidal and their successors shortly triangular, gradually becoming oblong but always much broader than long. Syzygies occur between brachials 3+4, again from between brachials 15+16 to between brachials 21+22 (generally at about the fifteenth or sixteenth brachials), and distally at intervals of from 6 to 12 (usually 8 or 9) muscular articulations. Of the four or more arms borne on each IIBr axillary the two outermost have much larger lower pinnules than the inner. P_2 may reach 15 mm. in length and be composed of nearly 30 segments, of which the lowest are very stout though not especially long. The corresponding pinnule on the inner arms is about two-thirds of its length, with fewer and smaller segments, and P_b is of nearly equal size, while on the outer arms it is considerably smaller than P_2.

P_3 is about equal to P_2, reaching 10 mm. in length, with 20 segments; but on the inner arms it is markedly smaller than P_b. In like manner P_1 on the outer arms reaches 12 mm., with nearly 30 segments, which are less stout than those of P_2 but still of considerable size at the base, while on the inner arms it is small and slender. P_a is always quite small. The disk is 17 mm. in diameter and is very deeply incised, almost to the level of the IBr axillaries. Sacculi are abundant along the pinnule ambulacra. In alcohol the disk is gray and the skeleton white more or less mottled with purplish or reddish gray in bands and patches.

Carpenter said that *Antedon conjungens* may readily be distinguished by the characters of its lower pinnules, which have more numerous and much shorter segments than those of *Antedon tuberculata* (=*Stephanometra spicata*) and its allies, while they are not of equal size on all the arms. Except on one postradial series in each specimen there are no IVBr series, so there are normally eight arms to each postradial series.

On the two outermost of these four arms the first three pinnules are much larger than their fellows on the inner pair. This is especially the case with P_2, so that while on the inner arms it is about equal to that on the next brachial it is half again as long and considerably stouter on the outer arms.

Carpenter said that a somewhat similar variation is presented by one of the types that have been distributed by the Godeffroy Museum under the name *Antedon protecta* Lütken. Thus in one individual, which he owed to the kindness of Prof. Sven Lovén, the first two pinnules on the outer pair of every four arms arising from a IIBr axillary are greatly larger than the corresponding pinnules on the inner arms. P_2 has 25 segments and reaches 12 mm. in length, being nearly three times the length of its fellow on the inner arm. In this type, however, according to Carpenter, P_3 on both the inner and outer arms alike has little more than a dozen segments and is only some 4 mm. long. The small size of P_3 is remarkable not only as distinguishing the type from *conjungens*, in which it is at least half the length of P_2, if not more, but also in the whole group of species with large P_2.

Carpenter said that each of the two examples of *conjungens* has normally eight arms to each postradial series, but a IIIBr axillary is occasionally absent, while in the D ray of each individual IVBr series are developed, one in one and two in the other specimen.

The specimen from Zamboanga is a beautiful large example of the species—one of the finest I have ever seen. It has about 43 arms. It is labeled *Comatula polyactinis*.

One of the specimens from Santa Cruz Island, Zamboanga, has 29 arms 95 mm. long, and another has 23 arms 50 mm. long.

In the specimen from Isabela, Basilan, the centrodorsal is thin discoidal, with the dorsal pole 3 mm. in diameter; the cirrus sockets are arranged in two irregular marginal rows. The cirri are XXIV, 26–29, from 23 to 25 mm. long. The pinnulation agrees with that of the type specimen of *aequipinna*, and this is in every way very similar to that specimen.

The specimen from *Siboga* station 99 has 30 arms 60 mm. long. The lower pinnules are very slender.

Of the three specimens from *Siboga* station 96 one has 30 arms about 60 mm. long, one 27 arms about 60 mm. long, and the third about 30 arms about 65 mm. long. In all three the enlarged lower pinnules, though long, are rather slender. The last in color is deep purple, with the dorsal pole of the centrodorsal and the dorsal side of the proximal half of the cirri white.

The specimen collected by M. March in the Philippines is of medium size.

Hartlaub said that in several specimens he had examined from Mortlock Island, some in the Hamburg and others in the Göttingen Museum, the outer sides of the postradial series are markedly flattened. The cirri are rather slender and short, 11 mm. long. P_2 is sometimes strongly recurved and sometimes quite straight and almost spinelike. It is always slender and not especially thickened at the base, as described by Carpenter in *brevicuneata*, and tapers to a very fine point. As in *imparipinna* P_2 is sometimes longer on the outermost arms of each postradial arms than on the inner arms. In color these specimens are deep purple-violet banded with light gray-violet on the arms. The alcohol in which they were preserved was stained deep red.

Hartlaub said that these specimens are intermediate between Carpenter's *similis* and *brevicuneata*. They possess six arms on each postradial series, the number characteristic of *similis*, and the IBr_1 are entirely visible, which according to Carpenter is characteristic of *brevicuneata*. In the relative length of P_4, which was also considered as of importance in differentiating these two forms, they show the relationship supposedly characteristic of *brevicuneata*, in which P_4 is markedly smaller than P_3. In its turn, P_3 is as long as P_2. Not rarely P_2 reaches 15 mm. in length, so that Carpenter was not correct in saying that *brevicuneata* in general has shorter lower pinnules than *similis*, in which, according to him, P_2 is 14 mm. long. Hartlaub remarked that the differences between *brevicuneata* and *similis*, if there are any constant differences, would be confined to the relative length of P_4.

I examined the two specimens at the Hamburg Museum in 1910. Each has 30 arms 80 mm. long. There are 22 or 23 cirrus segments. P_2 is 10 to 12 mm. long, rather slender, and composed of 26–37 segments. Though there is no apparent enlargement of the lower pinnules on the outermost arms of each postradial series, these are much longer, reaching 18 mm. in length.

In the three specimens from Ebon, Marshall Islands, which Hartlaub recorded as *brevicuneata*, the sides of the IBr and IIBr series, as in those he described from Amboina, show either no marginal thickening and lateral flattening or only here and there slight traces of these features. Hartlaub recalled that the specimen from Amboina in the Leyden Museum and the specimens from Mortlock Island that he had studied have postradial series with strongly flattened sides and marginal thickenings. In the specimens from the Marshall Islands there are no inner IIIBr series. The color of the three specimens is very different. One is uniform light brown. Another is light gray-brown in the central portion, darker in the outer portion. The third is uniform dark brown.

In a fragmentary specimen from Oahu, Hawaiian Islands, recorded as *brevicuneata* by Hartlaub, IIIBr series are developed only on the outer sides of each postradial series so that each postradial series bears six arms. This specimen is remarkable for the sharply delimited bands of white and brown on the arms.

Together with the fragments identified by Hartlaub as *brevicuneata* from Oahu there were two specimens that Carpenter had with some hesitation separated from *brevicuneata*. These Hartlaub recorded as *similis*. He said that these specimens possess the features characteristic of *similis*, namely relatively stout lower pinnules and a relatively slight difference in length between P_3 and P_4. The IIBr and IIIBr series, however, are not "wall-sided" as described by Carpenter for both *similis* and *brevicuneata*. The IIIBr series are developed only on the outer side of each IIBr series, so that each postradial series bears six arms. Because of the fact that the arms are bent back over the dorsal surface and entangled with each other, and because of the numerous closely crowded cirri, the relationships of the radials and of the elements of the IBr series cannot be well determined. The IBr$_1$ of *similis* are less completely visible than are those of *brevicuneata*. The color of the central portion of the specimens is uniform light gray-brown; the arms are dark brown interspersed with individual lighter brachials.

Hartlaub said that in a discussion of *brevicuneata* published in 1891 he had remarked that specimens from Mortlock Island he had studied show characters intermediate between those of *brevicuneata* and *similis*. He added that the eventual union of the two forms is not excluded.

The specimen from Vauna Mbalavu, Fiji, is very young, with 16 arms.

Hartlaub said that the three specimens from Ovalau, Fiji, in the Lübeck Museum that he examined show close agreement. In color two are gray-blue and one is reddish brown. In all the form of the centrodorsal is the same—a moderately large flat disk. The cirri, of which one specimen has XLVI and both of the others XXX, are not entirely confined to the margin of the centrodorsal, and are arranged in three irregular rows. The opposing spine is feeble. In two of the specimens the postradial series are in lateral contact, but in the third they are free. There are 38 or 39 arms.

Dr. H. L. Clark said that the dry specimen from Fiji collected by the United States Exploring Expedition seems to represent his *Lamprometra brachypecha*. It has 40 arms 65 mm. long.

One of the specimens from Fiji in the Copenhagen Museum, labeled *Antedon protectus* Lütken, is medium sized. The other two specimens are rather small. The difference in size between the pinnules on the outer and inner arms of each postradial series is not so great as usual, possibly because of immaturity. It may be that this feature does not become evident until a comparatively late stage in the development of the individual.

One of the specimens from *Challenger* station 174 was described by Dr. P. H. Carpenter as a new species under the name of *Antedon similis*. The centrodorsal is a thick disk with marginal cirri. The cirri are about XL, 25. The segments are tolerably uniform, and the later ones are compressed with a sharpened dorsal edge which passes into the opposing spine. The radials are entirely concealed. The IBr$_1$ are partially concealed and are closely united laterally. IIBr series are present all around the calyx, and IIIBr series are present on four of the postradial series, externally developed so as to give six arms to a ray arranged in 2,1,1,2 order. All the division series are 2. The elements of the IIBr and IIIBr series of adjacent postradial series are closely appressed laterally with sharp lateral edges and flattened sides. The 28 long and slender arms are 80 mm. in length and consist of about 150 brachials, of which the lower are discoidal and the rest shortly triangular, gradually becoming oblong, but always much broader than long. Syzygies occur between brachials 3+4, again from between brachials 17+18 to between brachials 22+23, and distally at intervals of from 9 to 17 muscular articulations. P_1 is about 7 mm. long and is composed of about 20 segments, which are but little longer than broad. P_2 is much stouter, reaching 14 mm. in length and consisting of nearly 25 rather longer segments. P_b is similar but rather smaller. P_3 is 6 mm. long with nearly 20 segments. P_4 is but little shorter than P_3 but consists of only a dozen segments. The disk is 12 mm. in diameter, naked, and rather incised. Sacculi are abundant along the pinnule ambulacra. The color in alcohol is a mixture of brownish white and greenish gray. I examined this specimen at the British Museum in 1910. It has 30 arms. None of the cirrus segments are quite so long as broad.

Carpenter said that *similis* stands very close to *brevicuneata*, and it was with some hesitation that he separated them. The large size of the centrodorsal and the lateral flattening of the postradial series appear in both types. But in *similis* the greater part of the IBr_1 is concealed, which is not the case in *brevicuneata*, while the lower pinnules are smaller in *brevicuneata*, though it is individually of larger size and has IIIBr series developed on all the IIBr series instead of on the outer side of each ray only. In *similis* P_4 is similar to and of almost the same length as P_3, whereas in *brevicuneata* it is a good deal shorter and has a smaller number of segments. It is in the relative proportions of these pinnules and the characters of the IBr_1 that the chief difference between the two types presents itself.

Three other specimens from *Challenger* station 174 were considered by Carpenter as representing a new species that he called *Antedon occulta* and described in the following terms: The centrodorsal is a thick disk reaching 6 mm. in diameter and bearing marginal cirri. The cirri are XXXV–XLV, 25–30. The segments are tolerably uniform, and the later are compressed laterally with a slight dorsal keel which passes into a faint opposing spine. The radials are entirely concealed, together with the greater part of the IBr_1 and also part of the IBr_2 (axillaries). The postradial series may divide four times. The lower ossicles of adjacent postradial series are in close lateral contact and somewhat flattened, but are not specially straight edged. All the division series are 2, and the axillaries are often somewhat asymmetrical. The 36–48 arms are up to 110 mm. long and are composed of about 170 smooth segments, of which the first few are oblong and those following are shortly triangular, gradually becoming oblong again but remaining much broader than long until near the end of the arm. Syzygies occur between brachials 3+4, again from between brachials 14+15 to between brachials 31+32, and distally at intervals of from 8 to 18 muscular articulations. The lower pinnules of the inner arms are generally rather smaller than those on the outer arms of each IIBr group, and more especially than those on the outermost arms of each postradial series. P_1 may be 7 to 9 mm. long, with 20–25 segments, the lowest of which are rather broad. P_2 reaches 10 or 15 mm. in length and may have 30 segments, the first half of which are very stout. P_3 is sometimes nearly equal to P_2, but it is usually considerably smaller both in length and in stoutness, while P_c is always much smaller than P_d. The disk is 12 mm. in diameter and is naked and more or less incised. Sacculi are abundant along the sides of the pinnule ambulacra. The color in alcohol is dorsally brownish white, with the perisome the same or greenish gray.

Carpenter said that the three individuals upon which he based his *Antedon occulta* are somewhat variable in their characters but apparently belong to the same specific type. They were taken in the same dredge haul as the type specimen of *Antedon similis.* They all agree in the presence of one or more IVBr series, in the great development of the centrodorsal, which partially covers the axillaries, and in the absence of the sharp straight edges to the elements of the IIBr and IIIBr series on the outer sides of the postradial series which are so marked in *similis.* Carpenter remarked that they are therefore pretty clearly distinguished both from *similis* and from its close ally *brevicuneata.* But they vary considerably in the characters of their lower pinnules. Those on the outer sides of each group of arms arising from a IIBr axillary, and more especially on the outer side of the outermost arms of each postradial series, are generally rather longer and stouter than the corresponding pinnules on the inner arms. But Carpenter was unable to make out any great constancy in this arrangement, and it is much more marked in one of the two specimens with the lower pinnules exposed than it is in the other. P_3 is generally much smaller than P_2, though sometimes nearly or quite equal to it in size, a character that may occur on the inner as well as on the outer arms. In the individual that shows the greater inequality of the pinnules on the inner and outer arms they are generally stiffer and more styliform than in the more regular example. The latter, according to Carpenter, thus presents an approach toward *conjungens*, while the former rather resembles *Antedon protecta.* These two species, however, have much less closely approximated postradial series and a smaller centrodorsal, which leaves the IBr_1 visible as well as the axillaries. I examined these three specimens at the British Museum in 1910.

Two specimens from the Tonga Islands in the Hamburg Museum were described by Dr. Clemens Hartlaub in 1890 as a new species, *Antedon lepida,* in the following terms: The centrodorsal is convex. The cirri are about XVIII, 20–25, 12 mm. long. The distal cirrus segments are spiny. The radials are partially visible. The IBr_1 are short and are free laterally. The IBr_2 (axillaries) are short. IIIBr series are present only on the outer side of the IIBr axillaries. There are no IVBr series. Each postradial series bears six arms. The postradial series are only slightly separated. The 30 arms are 40 mm. long, and have a smooth dorsal surface. The brachials are triangular, later becoming bluntly wedge-shaped. The second syzygy is at about the fifteenth brachial, and the distal intersyzygial interval is six or seven muscular articulations. The lower pinnules are very slender. P_1 is 4 mm. long. P_2 is 9 mm. long and is composed of about 20 segments, of which the outer are somewhat elongated. P_3 is approximately of the same length, though a little smaller. P_4 is markedly smaller. P_5 and P_6 are 3 mm. long. The succeeding pinnules then increase in length, reaching 5 mm. The disk is 10 mm. in diameter and is deeply incised.

Hartlaub said that this species is distinguished by its very delicate structure and by the fact that P_3 is almost as long as P_2. Additional characters are the spines on the distal cirrus segments and the absence of lateral contact between the IBr_1, although the postradial series are only slightly separated.

In 1891 Hartlaub placed *Antedon lepida* under the synonymy of *Antedon palmata* (=*Lamprometra klunzingeri*). He said that the differences between *lepida* and *palmata* are not significant, and the two specimens described as *lepida* are apparently young individuals of *palmata*. They are not sexually mature. Apart from their small size they are characterized by having the IBr_1 entirely free laterally, a feature that he had not seen in any specimen of *palmata*. In addition, P_3 is almost as long as P_2, and finally, in one of the specimens at least, the spines on the distal cirrus segments are more sharply differentiated than in any specimen from the Red Sea that he had seen. In 1910 I examined the two cotypes of *Antedon lepida* at the Hamburg Museum and found them to represent the present species.

In the *Challenger* report Carpenter mentioned *Antedon protecta* from Tonga and Fiji in various places, regarding it as a valid species. He said that he had a specimen that he owed to the kindness of Prof. Sven Lovén. In this the first two pinnules on the outer side of the outermost arms arising from every IIBr series are greatly larger than the corresponding pinnules on the inner arms. P_2 has 25 segments and reaches 12 mm. in length, nearly three times the length of its fellow on the inner arms.

In the key to the species of the *Palmata* group Carpenter placed *protecta* with *conjungens*, *aequipinna*, *laevicirra*, and *imparipinna*, these species being distinguished by having two or more axillaries beyond the IBr axillary, P_2 larger than P_3, the postradial series free laterally, and P_2 with 25 or more segments, which are not specially elongated. These five species he arranged in two groups, one, in which the lower pinnules are larger on the outer arms arising from each IIBr axillary than on the inner, including *protecta* and *conjungens*, and the other, in which the lower pinnules are fairly uniform in size on all the arms, including *aequipinna*, *laevicirra*, and *imparipinna*. In *protecta* P_3 was said to be quite short, while in *conjungens* P_3 is not especially short, being nearly as long as P_2 on the inner arms. He mentioned the characters of *protecta* in his discussion of *Antedon conjungens*, and later said that *Antedon similis* resembles *protecta* rather than *conjungens*.

The specimen from Tonga in the British Museum is typical.

Hartlaub in 1890 described *Antedon protecta* (Lütken, MS.) as a new species, possibly synonymous with *Antedon imparipinna* Carpenter, from the Indian Archipelago and Polynesia, in the following terms: The centrodorsal is from moderately large to large. The cirri are XXV–XLVI, 22–25, and are arranged in two, or in two and a partial third, rows on the centrodorsal. The cirrus segments are of fairly equal size. The opposing spine is feeble. The radials are partially or entirely concealed. The IBr_1 are short and are partially united laterally. The IBr_2 (axillaries) are pentagonal. The postradial series are mostly in fairly close lateral contact. The outer edge of the postradial series is occasionally crenate. The postradial series divide three times. There are usually nearly 40 arms 70 mm. long. Most of the brachials are triangular and bluntly wedge-shaped. The second syzygy is from between brachials 13+14 to between brachials 17+18, and the distal intersyzygial interval is from 8 to 11 muscular articulations. The outermost arms arising from each IIBr axillary bear larger lower pinnules than the inner arms. P_1 is slender, with 12–35 segments, and is about as long as P_2. P_2 is much thicker, moderately stiff, and is by far the stoutest pinnule on the arm; it is 10–17 mm. long and is composed of from 14 to more than 30 smooth cylindrical segments. P_3 is very small, and the pinnules following are still smaller. The disk is about 17 mm. in diameter and is deeply incised.

In 1891 Hartlaub wrote that after repeated comparisons between the specimens that he had described as *protecta* and the type specimen of Carpenter's *imparipinna* he had become convinced that the two forms are identical. The type specimen of *imparipinna* is in a condition very unfavorable for the description of the lower pinnules, because the arms are all bent in over the disk, and it is not surprising that the chief character of the species, the difference in size between the P_2 on the outer and inner arms, escaped Carpenter's notice. Another character of no less importance, the extraordinary smallness of P_3 in comparison with P_2, was, however, rightly emphasized by Carpenter.

The two specimens in the Hamburg Museum labeled Tonga and Fiji upon which Hartlaub, in part at least, based his *Antedon protecta* are both small.

The three specimens from Tonga in the Berlin Museum, which were received from the Godeffroy Museum, have 40 arms.

The specimen from New Caledonia has 40 arms.

The specimen from Ugi, Solomon Islands, is typical with 30 arms about 70 mm. long and the cirri XXII, 24, 15 mm. long.

The two specimens collected by the *Gazelle* at Bougainville Island agree perfectly with a series from Singapore in the Zoological Museum at Copenhagen. Each has 40 arms and is dark brown in color.

One of the specimens from Mer, Murray Islands, is the type specimen of Dr. H. L. Clark's *Lamprometra brachypecha*. He described it as follows: The centrodorsal is large, thick, and flat, 5 mm. in diameter, with the bare dorsal area about 2.5 mm. across. The cirri are XXXVI–XLVI, 22–25, and are distally compressed laterally. All the cirrus segments are broader than long. The distal segments have a very inconspicuous and low longitudinal ridge. The opposing spine is very small. The 39–50 arms are 50 to 60 mm. long and 10 to 12 mm. (?) broad distal to the middle. They are notably short and are composed of about 100 brachials. There are no lateral processes and no tubercles. The basal brachials are slightly swollen either in the middle or at the distalmost corner. The first few brachials are nearly quadrate, but those succeeding rapidly become low wedge-shaped, twice as broad as long, and then quadrate again as the tip of the arm is approached. Syzygies occur between brachials 3+4 and 15+16 (or 18+19), and distally at intervals of 10 to 20 (usually 11) muscular articulations. The lower pinnules on the outer side of every first and fourth arm are much bigger than any others. P_1 is usually about 10 to 12 mm. long, with 23 or 24 segments, more or less cylindrical and stiff, but somewhat flagellate at the tip. P_a is about the same. P_2 is bigger than P_1 to a greater or less degree, often 13 or 14 mm. long, with 25 segments. P_b is similar but smaller. P_3 is very small, not half of P_2, with 8–11 segments. P_c is about the same. The succeeding pinnules gradually become longer and at the middle of the arm are 6 to 8 mm. long and composed of 19 or 20 segments. All the pinnules are more or less cylindrical and are composed of perfectly smooth segments. The color in life is bright green, somewhat variegated with brown and white and with a broad band of white crossing each arm distal to the middle.

This band is particularly marked on the oral surface. Between this band and the disk are three or four narrow bands of green. The pinnules, at least distally, have yellow tips. The colors slowly undergo some change in alcohol, but the pattern is well preserved.

Dr. Clark said that there is no doubt this species is near *laevicirra*, but the small size, short arms, fewer segmented cirri, and the color are all distinctive. He added that there is a faded specimen in the Museum of Comparative Zoology collection from Fiji that seems to be *brachypecha*.

In 1918 I placed *brachypecha* under *protectus* (=*palmata*) as a synonym. In 1921 Dr. Clark said that I regard *brachypecha* as a synonym of *Lamprometra palmata*, which, according to my interpretation, is a protean species indeed. He said that there are specimens of *palmata* ("*protecta*") in the Museum of Comparative Zoology from Ceylon and from the Philippines, and he saw no ground for considering *brachypecha* identical with them. He remarked that the differences are obvious. He added that there is no evidence that *palmata* occurs in the Torres Strait region or elsewhere on the coast of Australia. On the other hand, he said, a dry comatulid in the Museum of Comparative Zoology collection from Fiji seems to be *brachypecha*, and I list *palmata* from Fiji. Perhaps intensive reef work at Fiji would settle the question as to the relationship of the two forms.

The holotype of *Lamprometra brachypecha* (M. C. Z., 551) is a form of *palmata* with the lower pinnules rather more slender than usual.

The seven specimens from the northern coast of Australia recorded by Dr. H. L. Clark are described as uniformly dark brown, lightest on the centrodorsal and nearly black at the tips of the pinnules and on the disk; when dry the color is much lighter, almost pale fawn color dorsally. The smaller specimens have the arms about 60 mm. long, while the larger ones have them more than 90 mm. long. The cirri are XXXV–XL, about 25. P_2 is very long, especially on the outer sides of the arms, with as many as 35 segments in some cases. There are about 40 arms in the smaller specimens, but in the larger there are 47 and 48.

The 17 specimens from New Guinea are medium sized or small. The largest has 51 arms about 80 mm. long. Most of the specimens have about 40 arms.

One of the specimens from Salawatti has 34 arms about 100 mm. long. The cirri are XL, 24–27, 16 mm. long. The bare polar area of the centrodorsal is flat, 3–4 mm. in diameter. Another specimen from Salawatti has 30 arms about 100 mm. long. The cirri are XXVIII, 27–28, 20 mm. long. The bare dorsal pole of the centrodorsal is flat and measures 3–4 mm. in diameter. The color of both specimens is dull pinkish blotched with bluish gray.

The specimen from *Siboga* station 164 is small and badly broken.

Carpenter thus described *Antedon laevicirra* from the Aru Islands: The centrodorsal is discoidal with a flat cirrus free dorsal surface, bearing the cirri in a single or partially double marginal row. The cirri are about XXX, 25–30. The cirrus segments are smooth and tolerably uniform, few or none being longer than broad. The penultimate has a faint opposing spine. The radials are not visible. The IBr_1 are short and nearly united laterally. The IBr_2 (axillaries) are more than twice their length, and are pentagonal with wide distal angles. The postradial series divide three times, all the division series being 2. The ossicles immediately following each axillary are closely united to their fellows. There are nearly 40 arms 125 mm. long and consisting of about 160 smooth brachials. The first brachials are almost rhomboidal, relatively long and narrow, and are closely united to their fellows. The second brachials are much shorter and nearly oblong. The first syzygial pair (composed of brachials 3+4) is nearly square. The next six brachials are short and nearly oblong, and those following are longer and sharply wedge-shaped with traces of a forward projection alternately on opposite sides as in *Antedon brevicuneata.* The outer brachials become blunter, and squarer and slightly elongated toward the arm ends. The first syzygy is between brachials 3+4, the second is from between brachials 19+20 to between brachials 22+23, and the distal intersyzygial interval is 10 to 14, usually 12, muscular articulations. The longest and stoutest pinnules on the arm bases are P_2 and P_b; P_2 consists of about 25 tapering segments and is considerably larger than P_b. P_3 and P_c are smaller than P_1 and P_a, and the pinnules of the fourth pair (P_4 and P_d) are still smaller, being the smallest pinnules on the arm. The length of the pinnules following gradually increases but never reaches that of the pinnules of the second pair (P_2 and P_b), and their component segments are not specially delicate, while they are well clothed with perisome up to the arm ends, where the size again decreases. The disk is 12 mm. in diameter and is naked and somewhat incised. The color is blackish, with lighter bands.

In the type specimen of *Antedon laevicirra,* which I examined at the Leyden Museum in 1910, the dorsal pole of the centrodorsal is flat and rather broad. The cirri are XXII, 24–28. The eighth-eleventh cirrus segments are very slightly longer than broad, and the last ten or twelve are rather sharply carinate, in dorsal view showing an elongate median tubercle. There are 37 arms. The division series are entirely free laterally, though close together. The proximal pinnules resemble those of the slender-pinnuled varieties of *Lamprometra palmata.* The second and third segments of the lower pinnules are slightly carinate.

In 1911 I wrote that the division series of this form resemble those of *L. palmata;* in fact, the whole animal is so much like the slender pinnuled form of *palmata* that I should not be surprised if the two eventually proved to be identical. The earlier pinnules on the outer side of the outer arms are considerably larger than those on the inner side of those arms, or on the inner arms.

The three specimens from *Siboga* station 279 are similar to the specimen from station 248. One has 39 arms about 100 mm. long; P_2 is rather slender, greatly enlarged on the outer side of the outermost arms of each postradial series, and nearly as large on the side of the IIBr series adjacent to the midradial line. The two other specimens have 37 and 40 arms.

Of the two specimens from *Siboga* station 174 one has 39 arms 75 mm. long, and the other has 26 arms 65 mm. long. In both P_2 is markedly enlarged only on the outermost side of each postradial series.

The specimen from Maratoea has 20 arms 65 mm. long; all the IIBr series are present.

One of the examples from Palelch has 33 arms 100 mm. long; the other has 24 arms 100 mm. long.

The two specimens from Sipankot are both small. One has 12 arms 20 mm. long. P_2 is similar to P_1 but smaller and shorter. The second segment of P_1 and P_2 has a high, thin, carinate ridge. The third segment is rarely similarly carinate; usually it has a low carination in the proximal portion that dies away distally.

The specimen from Sissie has about 34 arms. The outermost P_2 on each postradial series are very large.

The specimen from Wotap is small, with 18 arms 45 mm. long, and is undergoing adolescent autotomy.

One of the specimens from Obi latoe has 35 arms 80 mm. long.

The specimen from Beo, Talaud Islands, is small and young.

The example from Laha, Amboina, has 40 arms 100 mm. long, all the IIBr and IIIBr series being present. The proximal pinnules are much larger on the outermost sides of the postradial series than elsewhere.

One of the four specimens from Lembeh Strait, Celebes, has 38 arms about 110 mm. long. Another has 37 arms 115 mm. long. A third has 24 arms 80 mm. long; on the outermost arms of each postradial series P_3 resembles P_2, but is shorter. The fourth has 21 arms 100 mm. long and resembles the preceding.

Carpenter described *Antedon brevicuneata* from Amboina in the following terms: The centrodorsal is a thick disk with a slightly hollowed dorsal surface and a single or partially double row of marginal cirri. The cirri are about XXX, 25–30. The cirrus segments are tolerably equal, the sixth and seventh about as long as broad and the next two or three just longer than broad. The segments following diminish gradually in size toward the end, but without developing dorsal spines except for a small and blunt one on the penultimate. The radials are not visible. The IBr_1 and IBr_2 (axillaries) are very convex dorsally, the former being shorter in the middle than at the sides where they are closely united to their fellows. The axillaries are short, pentagonal, with wide distal angles, less than twice the length of the IBr_2. The postradial series are in close lateral contact, but divide three times, each division series being 2. The ossicles of the primary arms on the outer side of the postradial series are somewhat flattened laterally where they are in contact with their fellows. The 39 arms are 90 mm. long. The first brachials are large and rhomboidal. The second are shorter and much more wedge-shaped. The first syzygial pair (composed of brachials 3+4) is nearly square, rather longer on the inner than on the outer side. The next five brachials are nearly oblong with slight forward projections alternately from the outer and inner sides of their distal edges. The following brachials are smooth, short, and wedge-shaped, retaining the forward projection about as far as the sixtieth, but much more markedly on some arms than on others. The later brachials gradually become blunted and nearly square at the extreme arm ends. The first syzygy is between brachials 3+4, the second is between brachials 5+6, 6+7, 10+11, or as far as 18+19, and the distal intersyzygial interval is 8 to 19, usually about 11, muscular articulations.

The largest and stoutest pinnule on the outer side of the arm is P_2, which is about 10 mm. long and consists of about 25 segments, which are stout at the base but taper away rapidly toward the end. P_b is similar but somewhat smaller. The relative sizes of P_1 and P_3 are rather variable, but both are smaller than P_2. P_4 is a good deal shorter than P_3 and only about one-quarter as long as P_2; it consists of only seven or eight small segments. The following pinnules gradually increase in length and size, and the segments of the later ones become more elongated; but they never reach the length of the large basal pinnules, nor are they very closely set. The disk is 10 mm. in diameter, naked and deeply incised, almost to the center. Sacculi are not very closely set on the pinnule ambulacra. The calyx and arm bases are white with darker patches; the lower portions of the arms are a dirty brownish gray, and their outer portions the same mottled with white.

In the type specimen of *Antedon brevicuneata*, which I examined at the Leyden Museum in 1910, the cirri are XXVIII, 20–23. The division series are not quite in lateral contact; they resemble those of the type specimen of *Antedon laevicirra* but are composed of slightly shorter segments. There are 39 arms. P_2 is large and stout, tapering distally to a slender tip. The pinnules on the outer arms are considerably larger than those on the inner. This specimen may be exactly matched with others from the Philippine Islands that I have examined.

Hartlaub in 1890 described *Antedon amboinensis* from some specimens from Amboina collected by Dr. J. Brock, as follows: The centrodorsal is flat discoidal, with the cirri arranged in two marginal rows. The cirri are XXV, 20–25, from 14 to 17 mm. long. The distal segments are sometimes carinate or bear a spine. The radials are almost entirely concealed. The IBr_1 are entirely united laterally. The IBr_2 (axillaries) are short. IIIBr series are developed only on the outer side of the IIBr axillaries, so that there are 6 arms on each postradial series developed in 2, 1, 1, 2 order. There are no IVBr series. The postradial series are in lateral contact. The arms are not over 30, usually about 30, in number, and are 75 to 95 mm. long. The brachials are short, triangular, and bluntly wedge-shaped. The second syzygy is from between brachials 14+15 to between brachials 23+24, and the distal intersyzygial interval is 9 or 10 muscular articulations. The lower pinnules are moderately stiff but not recurved. They are of equal length on both sides of the arms. P_1 is slender, especially distally, a good deal shorter than P_2, and composed of 16–20 elongated segments. P_2 is markedly stiffer and thicker than P_1, 10–12 mm. long, with 12–20 segments, of which the majority are longer than broad. P_3 is shorter and weaker than P_2, but longer than P_1. The two following pinnules decrease in length. The disk is 14–16 mm. in diameter and is strongly incised. Hartlaub said that this species recalls *brevicuneata* but differs from that species in the entire lack of a lateral flattening of the arm bases.

In 1891 Hartlaub described the five specimens from Amboina in greater detail: The centrodorsal is thick and large, with a flat dorsal surface. The cirri are arranged in two marginal rows. The cirri are about XXV, 20–25, from 14 to 17 mm. long. The sixth and seventh segments are somewhat longer than broad, and those following are about as long as broad, all of equal size. They become somewhat compressed and may bear a dorsal keel or even a prominent spine. The radials are usually dorsally visible at their sides. The IBr_1 are short and broad, wholly or almost wholly laterally united. The IBr_2 (axillaries) are short, short pentagonal or almost triangular. The IIBr and IIIBr series are 2. The IIIBr series are developed only on the outer side of the IIBr axillaries so that there are six arms to each postradial series. The union of the axillaries with the preceding ossicles is generally not at all, or only slightly, tubercular. The outer edge of the postradial series shows no thickening, but there are small notches between the individual ossicles. The postradial series are separated slightly or not at all, and thus are often in close contact.

There are not more than 30 arms, usually about 30, which are from 75 to 105 mm. long. The arms are long and slender with a smooth dorsal surface and short brachials. The first brachial is almost rhombic and is closely united interiorly with its neighbor. The second brachial is a little longer exteriorly than interiorly. The first syzygial pair (composed of brachials 3+4) is markedly broader than long. The next four brachials are short and discoidal, and those succeeding are almost triangular, later passing over into bluntly wedge-shaped. The distal brachials are more rectangular, and the terminal almost square. Syzygies occur between brachials 3+4, again from between brachials 14+15 to between brachials 23+24, and distally at intervals of 6 to 13 (usually 9 or 10) muscular articulations.

The lower pinnules are equally stout on all the arms, and are of approximately equal length on both sides of the arms. They are moderately stiff, although they are never styliform. Even the pinnules of the first pair may be rather stiff. The pinnules of the first pair are slender, becoming very slender terminally, and are composed of 16–20 elongated segments. They are markedly shorter than the pinnules of the second pair, which are much thicker and stiffer; these reach 10–12 mm. in length and are composed of 12–20 segments, which gradually become slenderer and which are mostly longer than broad. The pinnules of the next pair (P_3 and P_c) are usually shorter and taper more strongly, though they are always longer and thicker than the pinnules of the first pair. The length of the pinnules of the two following pairs decreases. The pinnules of the sixth pair measure about 5 mm. From the seventh pair onward the length of the pinnules increases, finally reaching about 8 mm.

The disk is 14–16 mm. in diameter and is strongly incised. Sacculi are thickly set on the pinnules. In color the central portion of the dorsal surface is light yellowish brown or gray-brown; on the arms dark and light shadings of brown alternate. The disk is dark gray-brown variegated with gray, or uniformly gray-brown. Or the central part of the dorsal surface is white or light brownish white, the distal half of the cirri dark brown with the exception of the terminal claw, which is white, and the arms broadly banded with white or light gray-brown and darker; the disk is gray-brown variegated with white or light brownish white.

Hartlaub said that he had examined the type specimen of *brevicuneata* at Leyden and had convinced himself that it shows the closest agreement, especially in its general habitus, with the specimens that he had described as *amboinensis*. If in spite of this he had permitted himself to refrain from identifying the specimens from Amboina with *brevicuneata* in his preliminary paper, it was because, apart from a lesser number of arms, a feature that he originally believed to be characteristic of that form—the lateral flattening of the postradial series—was lacking. He was confirmed in his belief that the lateral flattening of the postradial series is a fundamental character of *brevicuneata* by a study of a number of specimens from Mortlock Island that, without exception, show this feature very highly developed. Besides this, Dr. P. H. Carpenter wrote him briefly that he did not consider as *brevicuneata* one of Brock's specimens from Amboina that was sent him for an opinion. In suppressing *Antedon amboinensis* in his later memoir he was simply following his original opinion. The motive for this was given by a second letter from Carpenter, which induced him to subject the material from Amboina and from Mortlock Island at Göttingen to renewed minute and detailed comparison. Hartlaub said that the five specimens from Amboina, described in 1890 as *Antedon amboinensis,* differ from the type specimen of *brevicuneata* at Leyden in the smaller number of arms and especially in the absence of any flattening on the outer sides of the postradial series. He remarked that this character, so striking in a species of the *Palmata* group, is therefore not to be considered as a constant character of the species. He found the same character very strongly marked in a number of specimens from Mortlock Island.

In respect to the number of arms—six on each postradial series—the specimens from Amboina do not resemble Carpenter's type, which has eight arms on each postradial series, but instead resemble *Antedon similis.* Carpenter separated *similis* "with some hesitation" from *brevicuneata,* with which it shares the lateral flattening of the postradial series. The specimens from Mortlock Island are intermediate between the two forms. They have six arms on each postradial series, as is characteristic of *similis,* and entirely visible IBr_1, a feature by which, according to Carpenter, *brevicuneata* is separated from the other forms. In the relative length of P_4, which Carpenter likewise considered as of importance in differentiating the two forms, the specimens studied by Hartlaub showed the relationship supposedly characteristic of *brevicuneata,* in which P_4 is markedly smaller than P_3, and P_3 is as long as P_2. But P_2 not rarely measures 15 mm. in length, so that Carpenter was in error when he said that *brevicuneata* in general has shorter lower pinnules than *similis* in which, according to him, P_2 is 14 mm. long. The difference between *brevicuneata* and *similis,* if constant, would be limited to the relative length of P_4.

Five specimens from Amboina identified as *Antedon imparipinna,* under which form he included *Antedon protecta* as a synonym, were described by Hartlaub in 1891 as follows: The centrodorsal is sometimes a disk of moderate size with a small irregularly shaped free dorsal pole marked with pits and bearing the cirri on its somewhat sloping sides, and sometimes a thick disk with vertical sides and a broader flat or slightly concave smooth dorsal pole with a diameter up to 5 mm. The cirri are arranged in two, or two and a partial third, rows. The cirri are XXV–XLVI, 22–25. The segments are tolerably uniform. The three first segments are a little broader than long, the sixth–tenth (in the specimen from Ovalau the fourth–ninth) are somewhat longer than broad, and the remainder are again short and are laterally compressed. The outermost segments may be somewhat carinate and bear a dorsal tubercle or even a blunt spine. The opposing spine is usually only very feebly developed. The radials are either entirely concealed, or are only visible in small part in the interradial angles of the calyx. The IBr_1 are short, occasionally entirely free laterally, but usually more or less united laterally. They are as long as the two free sides of the pentagonal axillaries. The postradial series diverge only slightly, sometimes being in close lateral contact. They divide three times. The IIBr and IIIBr series are 2. As a rule there are no IVBr series. Slight synarthrial tubercles are present. The two ossicles immediately following each axillary are more or less united with each other, the $IIBr_1$ often only in the proximal half. The outer borders of the postradial series are notched at the articulations.

Rarely more than 40 arms, usually about 40. Occasionally one or two of the arms arise directly from the IBr axillary. The arms are 70 mm. long and smooth.

The two first brachials are a little longer exteriorly than interiorly. The first syzygial pair (composed of brachials 3+4) is about as long as broad. The next three or four brachials are discoidal, and these are succeeded by a moderately long series of short brachials, which are at first more or less triangular but later become bluntly wedge-shaped. Their distal border sometimes bears dorsally a small sharp process situated on alternate sides. The outermost brachials are as long as broad, though remaining feebly wedge-shaped. A characteristic feature of many arms is that their greatest width is reached at some distance from their base. The first syzygy is between brachials 3+4, the next usually from between brachials 13+14 to between brachials 17+18, and the distal intersyzygial interval is 8 or 9 muscular articulations. The two outer arms of the four arising from each IIBr axillary have longer lower pinnules than the two inner, and P_2 on the two outermost arms of each postradial series is remarkable for its special stoutness. These features are as a rule very pronounced, and when this is the case the disk is surrounded by 20 long pinnules, which are distributed in ten pairs, the two of each pair belonging to the outer arms of adjacent IIIBr series.

P_1 on the outer arms is thin and slender and has a very variable number of segments, these numbering between 12 and 35. It is about half as long as P_2, which is moderately stiff and is by far the longest and thickest pinnule of the arm. It has a length of 10 to 17 mm., and the number of its uniform smooth cylindrical segments may exceed 30, although very often there are not more than 14–20. The segments are about as long as broad. P_3 as a rule is very small, and P_4 is the smallest of all. The succeeding pinnules slowly increase in length, finally reaching about 5 or 6 mm. The two first pinnules on the inner side of the outer arms (P_a and P_b) are usually much shorter than the corresponding pinnules of the outer side; but P_c and P_d are of about the same length as P_3 and P_4. The disk is about 17 mm. in diameter and is deeply incised. Sacculi are thickly set on the pinnules. In color the dorsal skeleton shows different shades of brown, often variegated with a light gray-brown in bands and spots; the central portion is often uniform light gray or whitish brown. The disk is gray or gray-brown. Gray-blue specimens also occur.

Prof. Ludwig Döderlein recorded two specimens from Amboina under the name of *Antedon imparipinna.* He said that the assertion in Hartlaub's key to the species of the *Palmata* group that in *imparipinna* P_2 has 25 or more segments is misleading, though in the description of the species Hartlaub correctly states that the number is as large as this only on the outermost arms of each postradial series, this pinnule on the inner arms having not more than 14–20 segments. He said further that these elongated pinnules are in no way styliform or stiff, their condition not being quite satisfactorily expressed in Hartlaub's figures.

The eight specimens from Amboina recorded by Dr. August Reichensperger have 32–40 arms 70 to 100 mm. in length In four specimens P_2 is very long and slender, up to 18 mm. in length, and is composed of 28–30 segments. The cirri are XXV–XXXVIII, 26–29. The arms are closely appressed laterally. Another specimen has 32 arms. P_2 is only 11 mm. long, with 26–28 segments, and is very slender. The cirri are in this weaker and somewhat shorter than in the others and are composed of about 25 segments. Three specimens have P_2 up to 16 mm. long, stouter basally than in the preceding specimens and standing up more stiffly, flagellate only in the distal portion from about the eighth or tenth segment onward; they are composed of 27–30 segments. Two of these specimens have only XXII–XXVI cirri with 25–28 segments, which are very stout. The third specimen has XXXVIII cirri, which in part are more delicate. The last-mentioned three specimens are light brown. The first five are dark red-brown, with the cirri somewhat lighter.

Another specimen from Amboina recorded by Reichensperger as *Dichrometra palmata* (=*klunzingeri*) has 26 arms 85 mm. long. The cirri are XXII, 24–25, about 16 mm. long. The cirrus segments from the fourth to about the twelfth are longer than broad. The distal segments bear blunt spines. P_2 is not quite twice so long as P_1 and is composed of 22 segments. The basal segments of the proximal pinnules show an inclination to carination. The color is dark brown broadly banded with light brown.

The larger specimen from *Siboga* station 231 (Amboina) is a magnificent example with 40 arms 125 mm. long. P_2 is 22 mm. long with 40 segments and is greatly enlarged on all the arms, though considerably larger on the outer arms than on the inner. The other individual is smaller with 40 arms 80 mm. long.

The specimen from the Bay of Amboina, according to Professor Koehler, has the cirri XXXIII, 23–25. The dorsal spines on the distal segments are little evident. All the IIBr and IIIBr series are present, so that there are exactly 40 arms, which are 80–100 mm. long. The inequality of the lower pinnules on the outer and inner arms is very marked. The disk is about 10 mm. in diameter.

The single individual from *Siboga* station 89 has 40 arms 85 mm. long and the cirri XXVIII, 23–24, 20 mm. long. The lower pinnules on the outermost arms of the postradial series are markedly longer than the others. P_2 is 15 mm. long, with 30–32 segments.

The specimen form *Siboga* station 193 is similar to those from station 279.

The specimen from *Siboga* station 248 has 40 arms 120 mm. long. P_2 is greatly enlarged on the outer side of the outermost arms of each postradial series and considerably enlarged on the midradial side of the IIBr series, but is small elsewhere.

The details of the four specimens from *Siboga* station 303 (Haingsisi) are as follows: One has about 40 arms 75 mm. long. P_2 is much enlarged on the outer side of the postradial series and considerably enlarged on the arms next the midradial line. Another has 22 arms 75 mm. long. All the P_2 are enlarged, more so than in the preceding specimen. A third specimen has 23 arms 75 mm. long; it is similar to the first. The fourth specimen has 30 arms 65 mm. long and is also similar to the first.

The specimen from *Siboga* station 115 is a magnificent example with 40 arms 110 mm. long. The division series are entirely and rather widely separated. The dorsal pole of the centrodorsal is very slightly concave and is 4.5 mm. in diameter. The cirri are XIX (with numerous additional rudimentary cirri), 26–27, 20 mm. long. The distal cirrus segments bear slight dorsal tubercles. P_2 is 16 mm. long, very stout but tapering evenly distally to a delicate tip, and is composed of 29 segments. The lower pinnules on the outer side of each IIBr series are greatly enlarged instead of only those on the outer side of each IBr series as in smaller specimens.

The specimen from *Siboga* station 125 has 20 arms 80 mm. long. One IBr series does not divide further. P_2 is greatly enlarged on the outer side of the IBr series.

The specimen from Java collected by M. Philibert (labeled *Comatula dividuus*) has 41 arms. The postradial series are rather widely separated. The cirri have 25–28 segments, of which the distal are strongly carinate in the middorsal line. P_2 is very long on the outer arms of each postradial series and may have 30 segments. It is stout basally, but becomes flagellate distally.

The specimen from Gaspar Strait was described by Hartlaub as a new species under the name of *Antedon subtilis*. According to him the centrodorsal is flat discoidal, with the cirri arranged mostly in two rows. The cirri are about XX, about 20, about 12 mm. long. They are moderately slender, and are laterally compressed in the outer half. From the fifth onward the segments are somewhat elongated. The distal segments have a very feeble dorsal spine, and the antepenultimate a stronger spine. The radials are partially visible at their sides. The IBr_1 are short, somewhat shorter than the sides of the pentagonal axillaries. The IIBr and IIIBr series are 2. There are no IVBr series. The $IIBr_1$ and $IIIBr_1$ are about as long as the sides of the IBr_1 and IBr_2 together. The postradial series are entirely free from the radials onward. The ossicles of the division series and the brachials are entirely smooth. There are no synarthrial or articular tubercles. The 20 arms are 52.5 mm. long. One of the postradial series bears five arms, one three, and the other three four each. The arms are moderately slender, entirely smooth, and provided with very slender pinnules. The brachials are short and as far as the eighth are more or less discoidal, becoming markedly triangular from the ninth onward and so remaining until about the twentieth when they become more trapezoidal and later squarish. The first brachials are in partial contact interiorly. The first syzygy is between brachials 3+4, the second is between brachials 15+16, and the third is separated from the second by 6 or 7 muscular articulations. The distal intersyzygial interval is 7 or 8 muscular articulations. P_1 is about 7 mm. long and is composed of about 13 smooth segments, which with the exception of the two basal are elongated. P_2 is 10 mm. long, markedly stouter than P_1, and flagellate; as in P_1 the segments are elongated with the exception of the two first. The three following pinnules on the same side of the arm are very diminutive, and are only about 2 mm. long. The length of the pinnules then gradually increases, the pinnules of the middle portion of the arms remaining, however, small and slender. The pinnules of the arm tips are of a hairlike fineness, but somewhat longer (5 mm.); the segments are always elongated. The disk is deeply incised. Sacculi are abundant and closely set. The color in alcohol is uniform white.

Hartlaub said that *subtilis* is nearly allied to *Lamprometra klunzingeri* (see page 527) but differs from it in the smallness of P_3, which in *klunzingeri* is as long as P_1. He remarked that after a study of more material the two forms may be found to be identical.

The details of the specimens from *Siboga* station 78 are as follows: One has 21 arms 75 mm. long; P_2 on the outer arms is very large; all the proximal pinnules are considerably enlarged. A second has 21 arms 70 mm. long; P_2 is greatly enlarged on the outermost arms of each postradial series, where it stands out with great prominence. The others are similar; one has 26 arms, two have 25, and one has 22. The remaining three specimens are small.

One of the specimens from *Siboga* station 79*b* has 28 arms about 60 mm. long. The other is smaller.

One of the specimens from *Siboga* station 81 is a typical example with 40 arms 95 mm. long; P_2 is especially stout and very stiff; there are four large P_2 on each postradial series. A similar specimen has 30 arms 75 mm. long. The third specimen is smaller.

The specimen from Pulo Condor is a fine example of the species.

The specimen from the Danish Expedition to the Kei Islands station 104 is small.

Hartlaub said that the only essential difference between the specimen from Singapore collected by Jagor, which he assigned to *palmata* (=*Lamprometra klunzingeri*), and those that he described from the Red Sea lies in the quite different form of the centrodorsal, which is rather thin and quite flat, with a moderately large circular dorsal pole and the cirri confined to the margin. In the specimens from the Red Sea the centrodorsal is thicker and the bare dorsal pole is smaller. This specimen, which I examined in 1910, is small, with 27 arms about 70 mm. long. As it is rather poorly preserved, the large size of the pinnules on the outermost sides of the postradial series is difficult to appreciate. The outermost 10 or 11 cirrus segments have small sharp median tubercles.

One of the specimens collected by Svend Gad at Singapore has 40 arms 65 mm. long. The cirri are XXVI, 25, 20 mm. long; the distal cirrus segments are rather sharply carinate. P_1 is 7 mm. long with 20 segments. P_2 is 13 mm. long with 24 segments. P_3 is 5 mm. long. P_4 is the smallest pinnule, being only 4 mm. long. The difference in size between the pinnules on the outer sides of the IIBr series and the others is exceptionally well marked. Two others are similar to this. Another specimen has 40 arms 55 mm. long. There are XXVI cirri, which are 12 to 15 mm. long. The color of these four specimens is dull yellowish white, mottled and spotted with yellow-brown.

One of the specimens from Pulau Ubin has 41 arms 100 mm. long. The cirri are XXVI, 15 to 20 mm. long. P_1 is 10 mm. long, with 29 segments. P_2 is 17 mm. long, with 27 segments. P_3 is 5.5 mm. long, and P_4 is 4 mm. long. The color is very deep, nearly black. The two other specimens are similar; one has 40 and the other 27 arms.

The single mutilated individual from King Island in the Mergui Archipelago was recorded by Carpenter as *Antedon conjungens*. Carpenter said that like the other comatulids from this locality it is very darkly colored, while the two specimens found by the *Challenger* on the Cebu reefs are light gray, with occasional dark patches, and the margins of the lower parts of the postradial series are more produced toward the ventral side than is the case in the Mergui form. The characters of the cirri and of the arm divisions are, however, the same in both, and the pinnule arrangement is also generally similar in the two types. The largest pinnule is P_2, and this is much larger on the outer than on the inner arms of each IIBr series. On the outer arms of each IIBr series P_1 is also of considerable size, but on the inner arms it is a good deal smaller. Carpenter said that the chief point of difference between the Mergui and the Philippine specimens is in the size of P_3. On the outer arms of the Mergui individual its length relatively to P_2 is but little less than in the type specimens from Cebu, but on the inner arms the difference between P_2 and P_3 is more marked. Those of the type specimens are sometimes nearly equal, though not always so; but in the Mergui form the difference is often considerable. Carpenter said that it is not so great, however, as in *Antedon protecta*, in which P_3 is much reduced in size not only on the inner but also on the outer arms.

The specimen from Snod Island is very small.

The specimen from Port Blair, Andaman Islands, is a fine example of the species with 40 arms. The proximal pinnules are much larger and stouter than usual.

The specimen from Cinque Island, Andamans, has 15 arms. The color in life is recorded as having been "center whitish, outer half of arms deep orange brown."

Most of the 12 specimens collected by the *Investigator* at the Andaman Islands and bearing no further data have 30 arms, but some of them have 40. This series exhibits great variation in the size of the proximal pinnules; indeed, so much difference is there between the two extremes that were it not for the intergrades they would certainly be considered as representing different species. A rather large specimen with 30 arms 90 mm. long represents the condition in which the cirri and lower pinnules are remarkably small and weak, the latter especially being unusually slender with very little difference between those on the outermost sides of the post-radial series and the others so that it might almost be taken for a specimen of *Lamprometra gyges*. On the other hand, a specimen with 40 arms has remarkably large and stout lower pinnules with the difference between those on the outermost sides of the postradial series and the others exceptionally pronounced. Most of the specimens are quite typical and agree with others at hand from Singapore, the Philippine Islands, and other places in the East Indies.

Of the four specimens from Palk Strait one has 19 arms about 50 mm. long, and the cirri 15 mm. long. One has 21 arms about 45 mm. long and the cirri XII, 15 mm. long. Another has 26 arms, of which two arise directly from IBr axillaries; all the extra axillaries are externally developed. The fourth specimen has 29 arms 45 mm. long; IIIBr series are developed externally on all but one of the IIBr series; the cirri are 12 mm. long.

The specimen from *Investigator* station 91 on the Ganjam coast of India has 12 arms 35 mm. long.

The specimen from Madras, station 5, has 37 arms.

In the specimen recorded by Gislén from Trincomalee, Ceylon, there are 43 arms 50 mm. long. The weight is 7.15 grams, and the volume 5.75 cubic centimeters. The length of the ambulacral grooves is 23.04 meters. The specific weight is 1.24, and the length of the ambulacral grooves divided by the weight is 4.08.

The specimens from Neendakara Bar are slenderly built, and P_2, though greatly elongated and much stouter than P_1 or P_3, is rather slender.

The two specimens examined from Ramesvaram on the Gulf of Manaar are small.

Prof. Johannes Müller described *Alecto palmata* from India in the following terms: The centrodorsal is flat, two and one-half times as broad as high, slightly concave in the middle. The cirri are marginal, and are arranged in several rows. The cirri are XXXV–XXX, 20–24. The cirrus segments are slightly longer than broad, and the last ten have a small spine. The radials are only slightly visible. The IBr series are 2. The IIBr series are 2. Following the IIBr axillaries the arms may remain undivided, or there may be IIIBr series. The intersyzygial interval is 6–12 muscular articulations. There are about 35 arms. The lowest pinnules are larger than the others. Of the lowest pinnules P_2 is much larger than the others. P_3 is the next largest. From P_3 the length of the pinnules rapidly decreases. The color is blackish brown.

In 1849 Professor Müller redescribed this species under the name of *Comatula* (*Alecto*) *palmata*, listing specimens from India, the Red Sea, and Zamboanga ("Sambuangam"). In the redescription the number of arms is given as 35–45. The latter number is evidently taken from the specimen from Zamboanga in the Paris Museum (see page 483). The radials are very short. All the axillaries are so articulated with the preceding ossicles that they can be rocked toward the right and left. The brachials are cylindrical, not wedge-shaped. The covering of the disk is without plates, soft when wet but when dried rough to the touch because of being filled with spicules. The anal tube is long and slender and is near the central mouth. The expanse is nearly a foot (which would give an arm length of about 150 mm.). There is no evidence that any of these additions to the original description were taken from the specimens from the Red Sea.

The specimen from India in the Indian Museum has 30 arms.

The five specimens from ?India are small and medium sized.

The 22 specimens from the Ceylon Pearl Oyster Fisheries investigations, of which 12 were from station II, were considered by Chadwick as representing a new species, which he called *Antedon okelli* and described as follows: The centrodorsal is a moderately thick roughly circular disk with a flat or very slightly convex dorsal surface and sloping sides. The cirri are XX–XXV, 25–28. The more distal cirrus segments are laterally compressed and carinate, and the penultimate bears an opposing spine. The radials are distinctly visible. The IBr_1 are broad, well rounded, and form a tubercular elevation in their median line of junction with the IBr_2 (axillaries), which are broadly pentagonal and about half again as long as the IBr_1. The IIBr and IIIBr series are 2. The IIIBr series are borne upon the outer face of the IIBr axillaries of one or both sides of the postradial series, generally the latter. Synarthrial tubercles occur on both the IIBr and IIIBr series. The postradial series have slight marginal projections. Arms 26–30, about 50 mm. long and consisting of about 120 brachials of which the first seven or eight are moderately thick disks. These are followed by rather more than 20 triangular brachials, and these again by wedge-shaped ones, which become longer in proportion to their width as the tip of the arm is approached. Syzygies occur between brachials 3+4, 14+15 or 15+16, 22+23 or 23+24, and distally at intervals of 8 or 9 muscular articulations.

P_1 is composed of 18–20 segments, of which only a few of the more distal ones are longer than broad. P_a is smaller and slenderer and composed of 16 or 17 segments. P_2 is considerably stouter and longer than P_1 and is composed of 20–22, or even 24, segments, which diminish in size more gradually. P_b has 19 or 20 segments but in all other respects is precisely like P_2. P_3 and P_c are smaller than P_1 and P_a, and composed of 14–16 segments. The basal segments of all these pinnules and of the pinnules of the three or four succeeding pairs are distinctly carinate, the latter especially so. The corresponding pinnules on the inner arms of the postradial series are a little smaller and have slightly fewer segments. The disk is 10 mm. in diameter and is deeply incised. Sacculi are abundant on the pinnules, less so on the disk. The color in alcohol of the specimens from station I is creamy white, mottled and striped with deep reddish brown; the margins of the bases of the postradial series and the long tubular anal funnel have spots of the same color. These were described as "black and white" when living. Others are ashy or purplish gray to deep purple, almost black. In the paler specimens the skeletal ossicles are marked with narrow bands of deep purple, and the disk has spots of the same color.

Chadwick said that *Antedon okelli* is closely allied to *A. brevicuneata*, *A. similis*, and *A. regalis*. It differs, however, from each of these in having the radials visible, a much smaller number of cirri, shorter arms, and carinate basal segments on the lower pinnules.

Dr. Hubert Lyman Clark said that the specimen from Ceylon that he recorded as *Dichrometra tenera* is a fine example with 40 arms and the cirri XL, 22–25.

Reichensperger said that seven of the specimens collected by Dr. Sarasin at Ceylon represent the same variety. There are 30–40 arms that do not exceed 75 mm. in length. In some they are very close together, and in others they are widely separated. The cirri are XXV-XXVIII, 26, from 18 to 20 mm. long. Three of the specimens have P_2 very long and slender, reaching 15 mm. in length and composed of 26 segments. P_1 is 8 mm. long, with 22 segments. P_3 is only 6 mm. long, and P_4 is still shorter. The color in alcohol is dark red-brown, with the proximal portion of the arms dorsally and the cirri light brown. In two specimens P_2 is slender, reaching only 10 mm. in length and being composed of about 22 segments. The cirri are about XXV, 25–26, up to 15 mm. long. The color is gray-brown. Two specimens in which P_2 is somewhat stiffer and stouter agree almost completely with the three with stout P_2 described by Reichensperger from Amboina. They are similarly light brown in color. Another damaged specimen from Ceylon, recorded by Reichensperger as *Dichrometra palmata* (=*klunzingeri*) has about 28 arms 115 mm. long. The cirri are XXIII, about 25. Most of the cirrus segments are longer than broad, and the distal bear blunt spines. The color is dark brown.

The specimen from Muhlos, Maldive Islands, has 14 arms 60 mm. in length.

The specimen from Gwada, Baluchistan, is small.

The specimen from the Arabian Sea has 42 arms, which are about 65 mm. long. P_2, though much stouter than P_1 and P_3 and greatly elongated, is unusually slender.

Carpenter described *Antedon aequipinna* from a specimen without locality in the Hamburg Museum in the following terms: The centrodorsal is discoidal bearing the cirri in a single or partially double marginal row, which leaves the flat dorsal surface free. The cirri are about XL, 24–28. The segments are tolerably uniform, smooth, and thick. The sixth is about square while those immediately following it may be a trifle longer than broad. The penultimate has a small blunt spine, a trace of which is sometimes visible on the preceding segment. The radials are not visible. The IBr_1 are short and broad, nearly oblong, and slightly united laterally. The IBr_2 (axillaries) are less than twice the length of the IBr_1, and are pentagonal with wide distal angles. The postradial series divide three or rarely four times, each division being of two ossicles of which the first are closely united to their fellows. The 43 arms are about 100 mm. long and are composed of 160 smooth brachials. The first brachials are almost rhomboidal, relatively long and narrow, and closely united to their fellows. The second brachials are much shorter than the first and are nearly oblong, slightly longer on the outer than on the inner side. The first syzygial pair (composed of brachials

3+4) and the next four brachials are transversely oblong with traces of forward and backward projections alternating on opposite sides. The following brachials are longer, though still short and sharply wedge-shaped, considerably broader than long, becoming blunter toward the middle of the arms and squarer toward the ends. The first syzygy is between brachials 3+4, the second is from between brachials 10+11 to between brachials 21+22, usually about brachials 17+18, and the distal intersyzygial interval is 7 to 13, usually 9 or 10, muscular articulations. The pinnules of the first pair (P_1 and P_a) are short, slender, and tolerably equal, with about 20 longish segments. The pinnules of the next pair (P_2 and P_b) are twice their length (13 mm.), much stouter, and rather stiff. P_3 is somewhat smaller than P_1, and the next four pinnules continue to decrease. The remaining pinnules gradually increase in length, becoming slender and delicate in the outer parts of the arms, but not longer than the pinnules of the second pair. The disk is 20 mm. in diameter, naked, and somewhat incised. The brachial ambulacra are close down between the muscles; those of the pinnules are more fleshy, with closely set sacculi. In color the dorsal skeleton is an alternation of purplish red and white, with alternating double rows of dark spots on the white parts. The disk is dark gray.

Carpenter said that this species comes very near *Antedon laevicirra* of the Leyden Museum. It differs, however, in having more numerous cirri, the second radials (IBr_1) less closely united, and shorter axillaries (IBr_2). The lower and middle brachials are relatively shorter, and the two pinnules of the second pair (P_2 and P_b) are more nearly equal than in *A. laevicirra*. The terminal pinnules also are much more delicate and less clothed with perisome. He remarked that the coloring is not unlike that of *Antedon* (*Dichrometra*) *bimaculata*, also in the Leyden collection; but in this species P_3 is larger than P_2, while the reverse is the case in *A. aequipinna*. In the key to the species of the *Palmata* group in the *Challenger* report *aequipinna* was grouped with *laevicirra* and *imparipinna* under the heading "the lower pinnules fairly uniform in size on all the arms." It was said to have P_2 and P_a large and tolerably equal, whereas in *laevicirra* and *imparipinna* P_2 is larger than P_b.

Hartlaub regarded *aequipinna* as identical with *imparipinna*. He said that apart from the characteristic coloration of its arms it shows the closest agreement with the specimens of *imparipinna* that he described from Amboina. The essential characteristic of *imparipinna*, the strikingly large size of P_2 on the outermost arms, is well marked, although Carpenter did not mention it. P_3 is relatively very small, although the difference between P_2 and P_3 is not so considerable as it might be. Hartlaub said that the specimens from Amboina show that this feature, which as a rule is extraordinarily pronounced, is occasionally almost lacking so that the unusual smallness of P_3 cannot be considered as a constant character.

Hartlaub said Carpenter's statement in the key to the species in the Hamburg Museum that in *aequipinna* "the fourth and fifth brachials bear large tolerably equal pinnules" is not, strictly speaking, correct. Hartlaub found in the type specimen of *aequipinna* the pinnule of the fifth brachial (P_b) is markedly smaller than that of the fourth (P_2). It is true that in the type specimen of *imparipinna* this difference is much more considerable, but in this specimen P_1 is of quite unusual size. Hartlaub said that as a very constant character for *imparipinna* the smallness of the opposing spine, which was also given by Carpenter, may be mentioned. Just how the type specimen of *conjungens* stands in this respect would be of interest to learn. That *Antedon aequipinna* has 43 arms instead of about or exactly 40 is of no importance, as IVBr series are occasionally present in one specimen from Amboina, which has 42 arms.

In the larger of the two type specimens, which I examined at Hamburg in 1910, the centrodorsal is broad, thin discoidal, with the cirrus sockets arranged in two irregular rows; the bare dorsal pole is 4.5 mm. in diameter. The cirri are about XXXVII, 22–28 (usually nearer the latter), 20 to 23 mm. long. The 40 arms are about 100 mm. long. P_2 is about 17 mm. long, moderately slender, with about 30 segments. It is greatly enlarged on the outermost sides of the postradial series and nearly as much so on the side of the IIBr series adjacent to the midradial line. The segments in the outer half of the cirri have a low sharp narrow median carination. The smaller specimen had probably between 25 and 30 arms. P_2 is slightly more slender than usual, resembling that in the other individual. The cirri have 22–23 segments.

Carpenter described *Antedon imparipinna* from a specimen without locality in the Hamburg Museum as follows: The centrodorsal is a convex disk with a slightly hollowed dorsal pole and two or three rows of cirri on its sloping sides. The cirri are XXXV, 25–28. The segments are smooth and thick, becoming about square on the sixth and then longer than broad, becoming shorter again toward the end. The penultimate segment bears a very faint blunt spine. The radials are partially visible at some of the angles of the calyx. The IBr_1 are widely hexagonal and are partly united laterally. The IBr_2 (axillaries) are not half again as long as the IBr_1; they are pentagonal with wide distal angles. The lines of junction of the axillaries with the ossicles above and below them are narrower than the ossicles themselves, giving the sides of the postradial series a somewhat jagged appearance. The postradial series divide three times, all the division series being 2. The ossicles immediately following each axillary are almost completely united laterally. The 38 arms are about 75 mm. long. The first brachials are almost rhomboidal, relatively long and narrow, closely united to their fellows. The second brachials are shorter and more wedge-shaped, longer on the outer than on the inner side. The first syzygial pair, composed of brachials 3+4, is oblong. The next four brachials are nearly so, but shorter. The following ones are longer, though still short, smooth, and sharply wedge-shaped, considerably broader than long. About the middle of the arm they become blunter, with forward projections alternately on opposite sides, and are squarer toward the ends. The first syzygy is between brachials 3+4, the second from between brachials 13+14 to between brachials 15+16, and the distal intersyzygial interval is 9 to 11 muscular articulations. P_1 is moderately long and tapers away rapidly after the basal segments, which are relatively rather large. P_a is considerably smaller. P_2 is unusually large and massive, reaching 15 mm. in length and consisting of 30 stout segments. The next two pinnules (P_b and P_3) are smaller again and about equal to P_1. The pinnules of the following pair (P_c and P_4) are still smaller, after which the length gradually increases, though it never much exceeds that of P_1. The disk is invisible. The diameter across the circle of IIBr axillaries is 13 mm. Sacculi are rather scanty on the pinnule ambulacra. The color is brownish white, with traces of darker spots.

Carpenter said that this species is distinguished from *Antedon aequipinna* by the great disproportion in the sizes of P_3 and P_4. It is much more marked than in *Antedon laevicirra*, which also differs in having more uniform cirrus segments, a longer interval between the first two syzygies, and less marked forward projections on the brachials.

I examined the type specimen of *Antedon imparipinna* at the Hamburg Museum in 1910. P_2 on the outer arms is exceptionally long.

There are two other specimens in the Hamburg Museum without locality. They are both typical. In one of them the proximal pinnules are rather long, and in the other they are rather short.

Forms.—The characters of the several named forms of this species may be appreciated by means of the following key. Some of these forms are perhaps worthy of recognition as representing fairly well marked and stable varieties, but most of them represent simply individual variants or growth or developmental stages.

KEY TO THE NAMED FORMS OF LAMPROMETRA PALMATA

a^1. Arms short, composed of about 100 brachials	**brachypecha** (p. 489)
a^2. Arms longer, composed of 150–170 brachials.	
b^1. Postradial series free laterally.	
c. Lower pinnules larger on outer arms arising from each IIBr axillary than on inner.	
d^1. P_3 quite short	**protecta** (p. 488)
d^2. P_3 not especially short, nearly as long as P_2 on inner arms	**conjungens** (p. 482)
c^2. Lower pinnules fairly uniform in size on all the arms.	
d^1. P_3 smaller than P_2; cirri smooth.	
e^1. P_2 and P_b large and tolerably equal	**aequipinna** (p. 502) **subtilis** (p. 498) **okelli** (p. 501)
e^2. P_2 larger than P_b.	
f^1. P_3 smaller than P_1; second syzygy about the twentieth brachial	**laevicirra** (p. 490)
f^2. P_3 equal to P_1; second syzygy about the thirteenth brachial	**imparipinna** (p. 504)
d^2. P_3 almost as long as P_2; cirri spiny	**moorei** (p. 481) **lepida** (p. 487)
b^2. Postradial series in close lateral contact.	
c^1. Cirri spiny.	
d^1. Over 30 cirrus segments; P_1 not much smaller than P_2; lower brachials with flattened sides	**gyges** (p. 517)
d^2. Not over 25 cirrus segments; P_1 much smaller than P_2	**palmata** (p. 500)
c^2. Cirri carinate, but not spiny.	
d^1. No IVBr series; lower brachials flattened laterally; radials visible.	
e^1. P_4 altogether smaller than P_3	**brevicuneata** (p. 492) **amboinensis** (p. 493)
e^2. P_4 nearly similar to P_3	**similis** (p. 485)
d^2. IVBr series present; IBr axillaries almost concealed by centrodorsal	**occulta** (p. 486)

Localities.—Hongkong [Hartlaub, 1891; Koehler, 1895; A. H. Clark, 1911, 1912; Mortensen, 1934] (1, H. M.).

Macclesfield Bank; 24 meters [Bell, 1894; A. H. Clark, 1908, 1912, 1913; Hartlaub, 1912] (1, B. M.).

Macclesfield Bank; 18–24, and 24, meters [A. H. Clark, 1929] (2, B. M.).

Nha'trang Bay, Annam; 40 meters; Dr. C. Dawydoff, July 14, 1928 [Gislén, 1936].

Pulo Condor, Cochinchina; 15 meters; Dr. C. Dawydoff [Gislén, 1936].

Albatross; Pangasinan Island, south point; reef; February 13, 1908 [A. H. Clark, 1908, 1911, 1912] (1, U.S.N.M., 35251).

Port Galera, Mindoro, Philippines; Lawrence E. Griffin [H. L. Clark, 1921] (10, M. C. Z., 633, 697, 698, 699, 700).

Challenger; Cebu reefs, Philippines [P. H. Carpenter, 1888, 1889; Bell, 1888; A. H. Clark, 1911, 1912, 1913] (1, B. M.).

Zamboanga, Mindanao, Philippines; MM. Hombron and Jacquinot (*Astrolabe* expedition), 1841 [J. Müller, 1849; A. H. Clark, 1911, 1912] (1, P. M.).

Dr. Th. Mortensen's Pacific expedition, 1914–1916; Santa Cruz Island, Zamboanga; coral reef; February 25–28, 1914 (4).

Isabela, Island of Basilan, south of western Mindanao, Philippines; Dr. J. Hallier [A. H. Clark, 1911, 1912] (1, H. M.).

Siboga station 99; anchorage off North Ubian (lat. 6°07′30″ N., long. 120°26′00″ E.); 16–23 meters; lithothamnion bottom; June 28–30, 1899 [A. H. Clark, 1918] (1, U.S.N.M., E. 400).

Albatross; Jolo (Sulu) anchorage, Jolo, Philippines; shore; March 5, 1908 (1, U.S.N.M., 36023).

Siboga station 96; Jolo (Sulu) archipelago, southeastern side of the pearl bank; 15 meters; lithothamnion bottom; June 27, 1899 [A. H. Clark, 1918] (3 U.S.N.M., E. 414; Amsterdam Mus.).

Albatross station 5158; Jolo (Sulu) archipelago, Tawi Tawi group; Tinakta Island (N.) bearing N. 89° W., 1.9 miles distant (lat. 5°12′00″ N., long. 119°54′30″ E.); 22 meters; coarse sand and shells; February 21, 1908 (1, U.S.N.M., 36052).

Albatross; Tataan Pass, Simulac Island, Philippines; February 19, 1908 [A. H. Clark, 1908, 1911, 1912] (1, U.S.N.M., 35265).

Philippine Islands; M. March, 1882 [A. H. Clark, 1911, 1912] (1, P. M.).

Albatross; Philippines; no further data [A. H. Clark, 1908] (4, U.S.N.M., 35252).

Philippines [A. H. Clark, 1911, 1912]; refers to the specimens listed above collected by the *Albatross.*

Philippines [H. L. Clark, 1921]; refers to the specimens listed above from Port Galera, Mindoro.

Mortlock Island, Carolines [Hartlaub, 1891; A. H. Clark, 1912] (2, H. M.).

Ebon, Marshall Islands; Rev. B. G. Snow, 1877 [Hartlaub, 1912].

Oahu, Hawaiian Islands [Hartlaub, 1912].

Hawaiian Islands [P. H. Carpenter, 1888; refers to the specimens recorded by Hartlaub from Oahu].

Suva, Viti Levu, Fiji (4, M. C. Z., 757, 758).

Suau Point, Vauna Mbalavu, Fiji; beach; Alexander Agassiz, November 25, 1897 (1, M. C. Z., 206).

Ovalau Island, east of Viti Levu, Fiji [Hartlaub, 1891; Koehler, 1895; A. H. Clark, 1912].

Fiji; United States Exploring Expedition [H. L. Clark, 1915, 1921] (1, M. C. Z., 60 [original number 2705; old number 40]).

Fiji [A. H. Clark, 1909, 1912] (3, C. M.).

Fiji [P. H. Carpenter, 1888; A. H. Clark, 1912, 1913] (1, B. M.).

Challenger station 174, B, C, or D; near Kandavu, Fiji (lat. about 19°06′ S., long. about 178°18′ E.); 411, 1,115, or 383 meters; coral mud; August 3, 1874 [von Graff, 1887; P. H. Carpenter, 1888; Hartlaub, 1891; Chadwick, 1904; A. H. Clark, 1907, 1909, 1912, 1913] (4, B. M.). The specimens could not have come from the depths given, but were probably taken in shore collecting.

Tonga Islands [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1909, 1912 (as Tonga and Fiji)] (2, H. M.).

Tonga Islands [P. H. Carpenter, 1888; A. H. Clark, 1909, 1911, 1912, 1913] (1, B. M.).

Tonga Islands; Museum Godeffroy [Lütken, 1874; Hartlaub, 1891; Koehler, 1895; A. H. Clark, 1909, 1911, 1912] (3, Berl. M., 3047).

Monu reef, Nukualofa, Tongatabu, Tonga Islands; Prof. W. A. Setchell, June 1926 (2, U.S.N.M., E. 1263).

New Caledonia; M. Reveillière, 1880 [A. H. Clark, 1911, 1912] (1, P. M.).

Ugi, Solomon Islands [A. H. Clark, 1912] (1, Australian Mus.).

Bougainville Island, Solomons; *Gazelle* [A. H. Clark, 1909, 1911, 1912; Hartmeyer, 1916] (2, Berl. M., 2202).

Blanche Bay, New Britain; Dr. Arthur Willey [Bell, 1899; A. H. Clark, 1912, 1913] (1, B. M.).

Mer, Murray Islands, Torres Strait; under side of large rock fragments on the southeastern reef flat; H. L. Clark, October 3, 1913 [H. L. Clark, 1915, 1921] (1, M. C. Z., 551).

Mer, Murray Islands, Torres Strait; east reef; H. L. Clark, September 26, 1913 [H. L. Clark, 1915, 1921] (2, M. C. Z., 590).

Northern coast of Australia [H. L. Clark, 1928].

New Guinea [Hartlaub, 1891; Koehler, 1895; A. H. Clark, 1912; Hartmeyer, 1916] (17, U.S.N.M., 35231; Berl. M., 5347 [2981]).

Salawatti, off the western end of New Guinea; *Gazelle* [A. H. Clark, 1909, 1912; Hartmeyer, 1916] (3, Berl. M., 3431, 5333).

Siboga station 164; south of Salawatti (lat. 1°42′30″ S., long. 130°47′30″ E.); 32 meters; sand, small stones, and shells; August 20, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Aru Islands; von Rosenberg [P. H. Carpenter, 1881, 1883, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1911, 1912] (1, L. M.).

Siboga station 279; Rumah Kuda Bay, Roma Island (north of the eastern end of Timor); 36 meters; mud and sand; December 11–13, 1899 [A. H. Clark, 1918] (1, U.S.N.M., E. 389).

Siboga station 174; Waru Bay, northern coast of Ceram; reef; August 28–29, 1899 [A. H. Clark, 1918] (2, U.S.N.M., E. 391).

Maratoea; reef; *Willebrord Snellius*, August 14–18, 1929 [A. H. Clark, 1936] (1, L. M.).

Paleleh; shore; *Willebrord Snellius*, August 22, 1929 [A. H. Clark, 1936] (2, L. M.).

Sipankot, near Sibutu, Sulu (Jolo); 3–6 meters; *Willebrord Snellius*, September 10–14, 1929 [A. H. Clark, 1936] (2, L. M.).

Sissie, near Misool; shore and reef; *Willebrord Snellius*, October 6, 1929 [A. H. Clark, 1936] (1, L. M.).

Wotap, Tenimber Islands; shore and reef; *Willebrord Snellius*, October 20–23, 1929 [A. H. Clark, 1936] (1, L. M.).

Obi latoe; shore and reef; *Willebrord Snellius*, April 23–27, 1930 [A. H. Clark, 1936] (2, L. M.).

Beo, Talaud Islands; 6–10 meters; *Willebrord Snellius*, June 14–21, 1930 [A. H. Clark, 1936] (1, L. M.).

Lembeh Strait, Celebes; *Willebrord Snellius*, September 25, 1930 [A. H. Clark, 1936] (4, L. M.).

Laha, Amboina; *Willebrord Snellius*, September 13, 1930 [A. H. Clark, 1936] (1, L. M.).

Amboina; coll. Ludeking [P. H. Carpenter, 1881, 1883, 1888; Bell, 1882; Hartlaub, 1891; Chadwick, 1904; A. H. Clark, 1907, 1909, 1911, 1912] (1, L. M.).

Amboina; Dr. J. Brock [Hartlaub, 1890, 1891; Koehler, 1895; A. H. Clark, 1909, 1912].

Amboina; Prof. Richard Semon [Döderlein, 1898; A. H. Clark, 1909, 1912].

Amboina; Professor Strubell [Reichensperger, 1913].

Siboga station 231; Amboina; reef; November 14–18, 1899 [A. H. Clark, 1918] (2, Amsterdam Mus.).

Bay of Amboina; MM. Maurice Bedot and C. Pictet [Koehler, 1895; A. H. Clark, 1909, 1912].

Siboga station 89; Pulu Kaniungan ketjil; 11 meters; coral; June 21, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 193; Sanana Bay, eastern coast of Sula Besi; 22 meters; mud; September 13–14, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 248; anchorage off Rumah Lusi, northern point of Tiur Island; down to 54 meters; December 4–5, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 303; Haingsisi, Samau Island; reef; February 2–5, 1900 [A. H. Clark, 1918] (4, Amsterdam Mus.).

Batjan, Moluccas; Ed. von Martens [Hartlaub, 1891; Koehler, 1895; A. H. Clark, 1912].

Siboga station 115; eastern side of Pajunga Island, Kwandang Bay, Celebes; reef; July 9–11, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

?Celebes [A. H. Clark, 1912] (1, I. M.).

Siboga station 125; off Sawan, Siau Island, north of the northeastern end of Celebes; 27 meters; stone and some lithothamnion; July 18–19, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Java; Herr Jagor [A. H. Clark, 1912] (1, Berl. M., 1845).

Java; M. Philibert [A. H. Clark, 1911, 1912] (1, P. M.).

Gaspar Strait, between Banka and Biliton [Hartlaub, 1895; A. H. Clark, 1907, 1909, 1912].

Siboga station 78; Lumu Lumu Shoal, Borneo Bank; 34 meters; coral and coral sand; June 10–11, 1899 [A. H. Clark, 1918] (9, U.S.N.M., E. 393, E. 398; Amsterdam Mus.).

Siboga station 79*b*; Pulu Kabala Dua, Borneo Bank; 22 meters; coral sand; June 12–13, 1899 [A. H. Clark, 1918] (3, Amsterdam Mus.).

Siboga station 81; Pulu Sebankatan, Borneo Bank; reef; June 14, 1899 [A. H. Clark, 1918] (3, Amsterdam Mus.).

Poulo Condor (Condore Island), Cochin China, off the mouths of the Mekong river [A. H. Clark, 1911, 1912] (1, P. M.).

Danish Expedition to the Kei Islands; Dr. Th. Mortensen; station 104; Java Sea (lat. 5°52′00″ S., long. 106°04′05″ E.); 38 meters; stones and sponges; August 4, 1922 (1).

Flying-fish Cove, Christmas Island; C. W. Andrews [A. H. Clark, 1929] (1, B. M.).

Christmas Island, Indian Ocean, south of the western end of Java (lat. 10°25′ S., long. 105°42′ E.) [A. H. Clark, 1934] (1, Raffles Mus.).

Singapore, 1899 [A. H. Clark, 1934] (1, Raffles Mus.).

Singapore; Herr Jagor [Hartlaub, 1891; A. H. Clark, 1909, 1912] (1, Berl. M., 2456).

Singapore; Svend Gad; shallow water [A. H. Clark, 1909, 1912] (22, C. M.).

Pulau Ubin, Johore Strait, between Singapore Island and the mainland; Marius Jensen [A. H. Clark, 1909, 1912] (3, C. M.).

King Island, Mergui archipelago; sublittoral [P. H. Carpenter, 1889].

Investigator; Snod Island, Mergui archipelago (lat. 12° N., long. 98°30′ E.) [A. H. Clark, 1912] (1, I. M.).

Investigator station 509; Port Maria, Elphinstone Island, Mergui archipelago; February 2, 1913 [A. H. Clark, 1932] (1, I. M.).

Investigator; Port Blair, South Andaman Island [A. H. Clark, 1912] (1, U.S.N.M., 35253).

Investigator; Cinque Island, Andamans [A. H. Clark, 1912] (1, I. M.).

Investigator; Andaman Islands [A. H. Clark, 1912] (8, U.S.N.M., 35226 [original No. 76B], 35233 [original No. 15B], 35235 [original No. 75B], 35249, 35254 [original number 77B], 35260 [original No. 23B], 35263 [original No. 25B], 35264 [original No. 38B]).

Andaman Islands [A. H. Clark, 1913] (1, B. M.).

Investigator station 91; 8 miles southeast of Bawanapadu Beacon, Ganjam Coast of India; 51 meters; February 20, 1890 [A. H. Clark, 1912] (1, I. M.).

Madras harbor, station 5; 9 meters; Dr. S. W. Kemp, May 3, 1918 [A. H. Clark, 1932] (1, I. M.).

Tuticorin harbor; shore collecting; Dr. H. S. Rao, February–March, 1926 [A. H. Clark, 1932] (27, I. M.).

Nam-Zit Island; edge of reef [A. H. Clark, 1912, 1913] (1, B. M.).

Investigator; entrance to Palk Strait, northeastern Ceylon; Point Pedro bearing southsoutheast, about 3 miles distant; 11–15 meters; sandy bottom [A. H. Clark, 1912; H. L. Clark, 1915] (5, U.S.N.M. 35632; I. M.).

Trincomalee, Ceylon; 7 meters [Gislén, 1924].

Investigator station 391; off the Travancore coast (lat. 9°14′10″ N., long. 75° 45′ E.); 433 meters; April 27, 1911 [A. H. Clark, 1932] (1, I. M.).

Needakara Bar, Travancore State; Drs. H. S. Rao and M. Sharif, February, 1928 [A. H. Clark, 1932] (27, I. M.).

Pamban [Thurston, 1894].

Ramesvaram, Gulf of Manaar [A. H. Clark, 1912, 1913] (2, B. M.).

Tuticorin, Madras [Bell, 1888; Thurston, 1894; A. H. Clark 1909].

East Cheval Par, Tuticorin [Thurston, 1894; A. H. Clark, 1909].

Gulf of Manaar; littoral; refers to the four preceding records collectively [Thurston, 1894; A. H. Clark, 1909].

India; Herr D. F. Eschricht [J. Müller, 1841, 1843, 1849; A. H. Clark, 1912].

India [A. H. Clark, 1912] (1, I. M.).

?India [A. H. Clark, 1912] (5, U.S.N.M., 35227 [original No. 35H], 35236 [original No. 42H]; I. M.).

Ceylon Pearl Oyster Fisheries station LVII; Gulf of Manaar; outside Dutch Moderagam Paar; 21–66 meters; bottom orbitolites sand, nullipores, and dead corals; 1902 [Chadwick, 1904; A. H. Clark, 1907, 1909, 1912; H. L. Clark, 1915].

Ceylon Pearl Oyster Fisheries station I; west coast of Ceylon; 5 miles west and southwest of Negombo; 22–36 meters; bottom coarse yellow sand with a few dead shells; 1902 [Chadwick, 1904; A. H. Clark, 1907, 1909, 1912; H. L. Clark, 1915].

Ceylon Pearl Oyster Fisheries station II; west coast of Ceylon; from 7 to 14 miles north of Negombo, 5 miles off shore; 15–16 meters; bottom coarse yellow sand, shells, stones, and small coral; 1902 [Chadwick, 1904; A. H. Clark, 1907, 1909, 1912; H. L. Clark, 1915].

Ceylon; from one of the three immediately preceding localities [Chadwick, 1904; A. H. Clark, 1907, 1909, 1912; H. L. Clark, 1915] (1, U.S.N.M., 35240).

Investigator; Colombo breakwater, Ceylon [A. H. Clark, 1912; H. L. Clark, 1915] (14, U.S.N.M., 35299, 35195, 36255; I. M.).

Ceylon [P. H. Carpenter, 1888].

Ceylon [H. L. Clark, 1915, 1921] (1, M. C. Z., 605).

Ceylon; Dr. Sarasin [Reichensperger, 1913].

Ceylon [Hartlaub, 1891; Chadwick, 1904; A. H. Clark, 1909, 1912; H. L. Clark, 1915].

Muhlos, Maldive Islands; Prof. J. Stanley Gardiner [A. H. Clark, 1929] (1, B. M.).

Investigator station 638; on reef flats on the outer side of Malikudu and Kaluhera Islands, Addu atoll, Maldive archipelago; February 25, 1923 [A. H. Clark, 1932] (1, I. M.).

Gwada, Baluchistan [A. H. Clark, 1912] (1, U.S.N.M., 35255 [original No. 12H]).

Arabian Sea; Dr. S. P. Agharkar, October 8, 1912 [A. H. Clark, 1932] (1, I. M.).

No locality [P. H. Carpenter, 1882, 1888; Bell, 1882; A. H. Clark, 1912] (2, H. M.).

No locality [P. H. Carpenter, 1882, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1911, 1912] (2, H. M.).

No locality [A. H. Clark, 1912] (1, H. M.).

No locality [A. H. Clark, 1912; Hartmeyer, 1916] (1, Berl. M., 5334).

Erroneous localities.—Suez Bay [A. H. Clark, 1912]; Suakim Harbor [A. H. Clark, 1912]; Red Sea [A. H. Clark, 1912]. The species referred to is *Lamprometra klunzingeri.*

Geographical range.—Fron Hongkong and the Philippines to the Caroline, Marshall, and Hawaiian Islands, Fiji, the Tonga Islands, New Caledonia, the Solomon Islands, and Torres Strait, and westward to Baluchistan.

Bathymetrical range.—Littoral and down to 51 (?433) meters. Of the 95 records no less than 76 are from the shoreline.

Habits.—Dr. Hubert Lyman Clark said that *Lamprometra brachypecha* was in many respects the most remarkable crinoid met with at Mer, but unfortunately it was rare and only four specimens, differing little in size or color, were found. These were all taken on the under surface of rock fragments on the southeastern reef flat. When the rock was overturned the arms would be more or less closed over the mouth, the whole animal appearing like a tuft of green seaweed. On being touched, however, the arms, instantly and all together, were laid back flat against the rock and the broad white band flashed into view. The immediate effect was obliterative, and one's first thought was that the animal had vanished. Whether this habit is protective, he said, could not be determined from the few observations possible. Much more critical study of the comatulid and its natural enemies is necessary before the truth can be ascertained.

Dr. Edgar Thurston wrote that he found this species in dense clusters in crevices in coral blocks at Tuticorin, and both in crevices in corals and on gorgonians at Pamban and Tuticorin.

Parasite.—The very small specimen from Snod Island has a minute parasitic *Melanella* on the ventral side of one of the arms (for an account of the molluscan parasites of crinoids see Part 2, pp. 645–649; *Melanella*, pp. 648–649).

The specimen from Madras, station 5, also has a *Melanella* attached to it, in this case at the base of one of the cirri.

History.—The *Caput-Medusae cinereum* described and figured by Linck in 1733 was in 1758 placed by Linnaeus in the synonymy of his *Asterias multiradiata.* Prof. Johannes Müller in 1841 and 1849 placed it with a query in the synonymy of his new species *Alecto palmata.* Dr. P. H. Carpenter in 1879 said that it may be determined with tolerable certainty to represent a species of the genus *Antedon,* as that genus was understood by him. Müller was probably correct in identifying *Caput-Medusae cinereum* with his *Alecto palmata,* although conclusive proof is lacking.

In 1841 Müller described *Alecto palmata* from a specimen from India in the Anatomical Museum in Berlin that had been presented by Dr. Daniel Frederic Eschricht, a celebrated Danish physician.

In 1849 Müller described the species at greater length under the name of *Comatula* (*Alecto*) *palmata* (see page 501), listing in addition to the type specimen others in the Zoological Museum at Berlin from the Red Sea collected by Hemprich and Ehrenberg, and in the Paris Museum from an unknown locality collected by Botta, and also from Sambuangam (Zamboanga) collected by Hombron during the expedition of the *Astrolabe.* As the type specimen was from India (understood, of course, in a broad sense) the name *palmata* must be applied to the widely spread and common species now under consideration instead of to the species confined to the Red Sea for which heretofore it has been used.

Dujardin and Hupé in 1862 failed to mention *palmata,* but in their list of manuscript names found with specimens in the Paris Museum they included *Comatula* *polyactinia*, which I found in the jar with the specimen from Zamboanga collected by Hombron and Jacquinot on the *Astrolabe* expedition in 1841, and *Comatula dividua*, which I found with a specimen from Java collected by M. Philibert.

In 1874 Prof. Christian F. Lütken listed *Antedon protectus* from the Tonga Islands. The name is a *nomen nudum*, but the specimens distributed under it include both this species and *Stephanometra protectus*.

Dr. P. H. Carpenter in 1879 assigned *palmata* to the genus *Antedon* as understood by him, also placing *dividua* and *polyactinis* (*sic*) which he had examined in the Paris Museum in that genus.

In 1881 Carpenter described *Antedon brevicuneata* from a specimen in the Leyden Museum from Amboina, and *Antedon laevicirra* from a specimen in the same museum that had been collected by von Rosenberg in the Aru Islands. At the same time he mentioned the *Antedon protecta* of Lütken.

In 1882 he described *Antedon aequipinna* from a specimen without locality in the Hamburg Museum, and *Antedon imparipinna* from another specimen without locaility in the same Museum.

Prof. F. Jeffrey Bell in 1882 published specific formulas for *Antedon palmata, A. brevicuneata*, and *A. laevicirra*. Early in 1883 Carpenter published revised formulas for these forms, and also formulas for *Antedon protecta, A. aequipinna*, and *A. imparipinna*.

In 1888 Bell recorded *Antedon palmata* from Tuticorin, Madras, from collections made by Edgar Thurston, of the Madras Government Central Museum, and also listed it as occurring in the Bay of Bengal. The specimens upon which this record was based represent both *Lamprometra palmata* and *Stephanometra protectus*.

In the *Challenger* report on the comatulids published in 1888 Carpenter included under the name *Antedon palmata* both *Lamprometra klunzingeri* from the Red Sea and *L. palmata*. This is evident from the range that he gave for the species—Red Sea; Ceylon.

In the remarks under the *Palmata* group he said that isolated specimens occur at the Sandwich Islands on the east and at Ceylon on the west. The mention of the Sandwich Islands was based upon some specimens of the present species that had been sent him by the Museum of Comparative Zoology with the *Blake* collection, which were later (1912) recorded and described by Hartlaub.

Carpenter described as new species and figured *Antedon conjungens*, based upon two specimens from the Zebu reefs; *Antedon similis*, based upon a single specimen from station 174; and *Antedon occulta*, based upon three specimens from station 174. In his key to the species of the *Palmata* group he included *protecta* Lütken, MS., and he mentioned this form in his discussion of *Antedon conjungens* and *A. occulta*. His interpretation of *protecta* was based upon a single specimen that had been sent him by Prof. Sven Lovén, which represented the present species. In the *Challenger* report on the stalked crinoids (1884) he had used the name *protecta* for the very different *Stephanometra protectus* (see page 443). The range of *protecta* he gave as Fiji; Tonga.

In 1889 Carpenter recorded and gave notes on a specimen identified as *Antedon conjungens* from the Mergui Archipelago and compared it with *A. protecta*.

In 1890 Dr. Clemens Hartlaub described *Antedon lepida* from two specimens from the Tonga Islands in the Hamburg Museum, *Antedon protecta* (Lütken, MS.) from the Indian Archipelago and Polynesia, no specimens being definitely mentioned, and *Antedon amboinensis* from Amboina, based on specimens collected by Prof. J. Brock. The last named he compared with Carpenter's *Antedon brevicuneata.* In his key to the new species described in this paper Hartlaub placed *lepida* under the heading "postradial series laterally more or less free" and the others under the heading "postradial series laterally more or less in contact." He distinguished these from each other and from *Antedon tenera* in the following manner:

a^1. Lower pinnules larger on outer arms of each IIBr series than on inner.
  b^1. P_2 robust; P_3 very short .... protecta
  b^2. Lower pinnules very slender, with a tendency toward carination .... tenera
a^2. Lower pinnules of approximately same size on all arms.
  b^1. No IVBr series .... amboinensis
  b^2. IVBr series present .... tenera

In his memoir on the comatulid fauna of the Indian archipelago published in 1891 Hartlaub placed *Antedon lepida* in the synonymy of *A. palmata* (=*Lamprometra klunzingeri*), which he redescribed from five specimens from the Red Sea in the Berlin Museum collected by Hemprich and Ehrenberg. He also referred to *palmata* (=*klunzingeri*) a specimen from Singapore in the Berlin Museum collected by Jagor.

Hartlaub redescribed *Antedon imparipinna* from five specimens from Amboina collected by Dr. J. Brock, placing in the synonymy of this species *Antedon protecta,* which he had described in 1890, and Carpenter's *Antedon aequipinna* and *A. conjungens.* He listed specimens from Amboina, the Tonga Islands, Batjan, Hongkong, New Guinea, and Ovalau.

On the basis of five specimens from Amboina he redescribed *Antedon brevicuneata,* placing as synonyms under it Carpenter's *Antedon similis* and his own *Antedon amboinensis.* He gave notes on the type specimen of *Antedon brevicuneata,* which he had examined at Leyden, and on some specimens from Mortlock Island and discussed at considerable length the relationships of *brevicuneata, similis,* and *amboinensis.*

Edgar Thurston in 1894 recorded *Antedon palmata* from Tuticorin, Pamban, and East Cheval Par and said that it occurred as a littoral form in the Gulf of Manaar. He gave a short account of its habits. His specimens had been identified by Bell and in addition to the present species included *Stephanometra protectus.*

In 1904 Herbert Clifton Chadwick mentioned *Antedon palmata* as being known from Ceylon, the reference having evidently been taken from the *Challenger* report, and described as a new species *Antedon okelli,* which was based upon 22 specimens collected in connection with the Pearl Oyster Fisheries Investigations in the Gulf of Manaar under the direction of Prof. W. A. (later Sir William) Herdman in 1902.

In my first revision of the old genus *Antedon* published in 1907, *brevicuneata, imparipinna, laevicirra, occulta, okelli, palmata,* and *subtilis* were all listed separately in the new genus *Himerometra.*

In 1908 Chadwick recorded *Antedon imparipinna* from Suez Bay and Suakim, Harbor, the specimens in reality representing the Red Sea species *Lamprometra klunzingeri.*

In my revision of the family Himerometridae published in 1909, *brevicuneata, occulta, okelli, palmata, protectus,* and *subtilis* were listed under the new genus *Dichrometra.* The name *protectus* (Lütken) was, although the fact was not stated, taken from a quotation from Lütken published by Carpenter in 1879 and was understood in the sense in which it was used by Carpenter in the *Challenger* report on the comatulids. But the *protecta* of the *Challenger* report on the comatulids (1888) is not the same as the *protecta* of the *Challenger* report on the stalked crinoids (1884), the *protecta* mentioned in Carpenter's paper on the comatulids of the Leyden Museum (1881), or Lütken's *protectus* quoted by Carpenter (1879), all of which are *Stephanometra protectus* (see page 443).

In another paper published in 1909, I recorded, under the name of *Dichrometra protectus*, two specimens from Bougainville Island and another from Salawatti, and also, under the name of *Dichrometra palmata*, two additional specimens from Salawatti. All these had been secured by the German steamer *Gazelle*.

In a paper on a collection of crinoids belonging to the Zoological Museum at Copenhagen published in 1909, I recorded, under the name of *Dichrometra protectus*, specimens from Fiji, Johore Strait, and Singapore.

In a paper on the crinoids of the coasts of Africa published in 1911, I recorded *Dichrometra protectus* from Suez Bay and Suakim Harbor, taking these records from Chadwick, and said that it ranges eastward to Hongkong, the Philippines, Fiji, and Tonga. I recorded *D. palmata* (=*klunzingeri*) from various localities in the Red Sea and said that it ranges eastward to the Tonga Islands.

In a paper on the crinoids of the Paris Museum published in 1911, I recorded *Dichrometra protectus* from New Caledonia, Java, the Philippines, Zamboanga, Philippines, and Pulo Condor, Cochinchina, and gave notes on the specimens. I mentioned that I had found the manuscript name *Comatula dividuus* with the specimen from Java, and the manuscript name *Comatula polyactinis* with the specimen from Zamboanga.

In a discussion of the crinoids of the Leyden Museum published in 1911, I placed Carpenter's *Antedon brevicuneata* and *A. imparipinna* in the synonymy of *Dichrometra protectus*, and gave notes on the type specimen of the former. Under the name *Dichrometra laevicirra* I gave notes on the type specimen of Carpenter's *Antedon laevicirra* and said that I should not be surprised if it eventually proved to be identical with *Dichrometra protectus*.

Under the name of *Dichrometra protectus* in 1911 I recorded and gave notes upon a typical specimen from Ugi, Solomon Islands.

In a paper on the crinoids of the Hamburg Museum published in 1912, I placed *lepida* Hartlaub, *aequipinna* and *imparipinna* Carpenter, and *brevicuneata* Hartlaub, 1891, under the synonymy of *Dichrometra protectus*, and recorded specimens from Tonga and Fiji (the types of *lepida*), no locality (the types of *aequipinna* and *imparipinna*, and two additional specimens), Hongkong, Mortlock Island, and Isabela, Basilan, and gave notes on them.

In a paper on the crinoids of the Berlin Museum also published in 1912, I recorded and gave notes on specimens from the Tonga Islands, New Guinea, Java, Singapore, Bougainville Island, and Salawatti, and also on one with no locality label.

In my memoir on the crinoids of the Indian Ocean published in 1912, as synonyms under *Dichrometra protectus* I placed *Comatula* (*Alecto*) *palmata* J. Müller, 1849 (in part), *Comatula dividua* Dujardin and Hupé, 1862, *Comatula polyactinis* Dujardin and Hupé, 1862, *Antedon protectus* Lütken, 1874 and 1879, *Antedon brevicuneata* P. H.

Carpenter, 1881, *Antedon protecta* P. H. Carpenter, 1881 and 1888, and Hartlaub, 1890, *Antedon aequipinna* P. H. Carpenter, 1882, *Antedon imparipinna* P. H. Carpenter, 1882, and Hartlaub, 1891, *Antedon conjungens* P. H. Carpenter, 1888, *Antedon amboinensis* Hartlaub, 1890, and *Antedon okelli* Chadwick, 1904. Bell's record of *Antedon indica* from Blanche Bay, New Britain, and part of the specimens recorded by Bell and later by Thurston from the Gulf of Manaar were also assigned to this species.

Specimens were recorded from Colombo breakwater, Ceylon, Port Blair, the Andaman Islands, and ?India, and in an appendix from Cinque Island, Andamans, *Investigator* station 91, and the entrance to Palk Strait. A complete list of the localities from which the species is known was given. The specimens from the Red Sea, Suez Bay, and Suakim Harbor, localities taken from Chadwick, should have been referred to *palmata* (=*klunzingeri*).

I listed *Dichrometra laevicirra* separately but said it would not be surprising if it should turn out to be the same thing as *D. protectus*. *Dichrometra similis* was also listed separately, and I said I was inclined to believe that it would turn out to be identical with *D. protectus*. I said further that Bell's *Antedon moorei* is apparently the same thing but is a young specimen; the spines on the cirrus segments are a trifle more conspicuous, and the animal is all around more slender, as would be expected. In the type of *similis* the cirrus segments are never quite so long as broad, the earlier being longer than broad in *moorei*, probably owing to the undeveloped condition of the latter.

Under *Dichrometra palmata* (=*klunzingeri*) specimens were recorded from Gwada, Baluchistan, Snod Island, and ?Celebes. Of the previous records for this species cited, Ceylon, Java, Singapore, Bougainville Island, and Tonga refer to the present species. It was noted that the specimen from Bougainville Island (recorded in 1909 as *D. protectus*) was identified as *palmata* (=*klunzingeri*) by P. H. Carpenter.

I listed *Dichrometra subtilis* separately and referred only to the type specimen.

In a list of undetermined species the original description of *Antedon moorei* was quoted, and notes on the type specimen were given. It was said to be an immature specimen of the species called *similis* by Carpenter, which is rather doubtfully distinct from *D. protectus*.

In 1913 Dr. August Reichensperger recorded *Dichrometra palmata* from Ceylon and from Amboina and gave notes on the specimens. He also recorded *D. protectus* from Amboina and Ceylon, giving brief descriptions of the specimens. Reichensperger said that the variations in *D. protectus* are chiefly in the relative development of the proximal pinnules, the number of the cirri, and the relative close approximation of the division series.

In a revision of the family Mariametridae published in 1913 I assigned this species and its various synonyms to the new genus *Lamprometra*.

In a paper on the crinoids of the British Museum published in 1913 *Antedon conjungens*, *A. similis*, *A. occulta*, *A. palmata*, of Bell, 1888, and Thurston, 1894, in part, *Antedon indica* of Bell, 1899, and the manuscript names *Antedon aequipinna* and *A. protectus* found with specimens in that institution, were placed in the synonymy of *Lamprometra protectus*. Notes were given on specimens from the Cebu reefs (the type of *conjungens* P. H. Carpenter), *Challenger* station 174 (the types of *similis* and *occulta* P. H. Carpenter), Ramesvaram, Gulf of Manaar, Blanche Bay, New Britain, Fiji (labeled *aequipinna*), Tonga (labeled *protectus*), the Andaman Islands, and Nam-Zit Island. I said I could not see that the type of Carpenter's *Antedon similis* presents any valid characters by which it may be separated from the earlier *Antedon protectus*. It also appears to be the same thing as Bell's *Antedon moorei*, though the type of the latter is a young and immature individual with the dorsal processes on the outer cirrus segments a trifle more conspicuous. The type of *similis* is regularly 30-armed and is in every way stouter than the type of *moorei;* the cirrus segments are never quite so long as broad, while the earlier are longer than broad in *moorei*. The pinnules of the type of *similis* resemble those of certain varieties of *protectus*.

In a list of unidentified species *Antedon moorei* was included, and notes on the type specimen were given.

In 1915 Dr. Hubert Lyman Clark described *Lamprometra callipecha* from a single specimen from Mer Island, Torres Strait, and in the same year he recorded two specimens of *Dichrometra protecta* and one of *D. tenera* from Ceylon.

In my memoir on the unstalked crinoids of the *Siboga* expedition published in 1918, I included under *Lamprometra protectus* as synonyms *Comatula* (*Alecto*) *palmata* J. Müller (in part), *Comatula dividua* and *C. polyactinis* Dujardin and Hupé, *Antedon protectus* Lütken [error], *A. brevicuneata* P. H. Carpenter, *A. laevicirra* P. H. Carpenter, *A. protecta* P. H. Carpenter, 1881 [error], *A. aequipinna* P. H. Carpenter, *A. imparipinna* P. H. Carpenter, *A. palmata* Bell, 1888, and Thurston, 1894 (in part), *A. protecta* P. H. Carpenter, 1888, *A. conjungens* P. H. Carpenter, *A. similis* P. H, Carpenter, *A. occulta* P. H. Carpenter, *A. indica* Bell, 1899, *A. lepida* Hartlaub, *A. protecta* Hartlaub, *A. amboinensis* Hartlaub, *A. palmata* Hartlaub, 1891 (in part), *A. subtilis* Hartlaub, *A. okelli* Chadwick, *Himerometra helianthus*, or *heliaster* A. H. Clark [error], *Lamprometra brachypecha* H. L. Clark, and *L. callipecha* H. L. Clark. Specimens were recorded from 16 *Siboga* stations, and notes were given on them.

In 1921 Dr. H. L. Clark took exception to my placing his *Lamprometra brachypecha* in the synonymy of *L. protectus* (=*palmata*) and maintained it as a distinct species. His *Lamprometra callipecha*, which I had placed in the synonymy of the present species in 1918, he regarded as a distinct species under the name of *Stephanometra callipecha*. It is considered herein as a synonym of *Stephanometra indica* (see page 436).

Gislén in 1924 discussed in detail the structure of this species and recorded a specimen from Trincomalee, Ceylon.

In a paper on some recent crinoids in the collection of the British Museum published in 1929, I recorded, under the name *Lamprometra palmata*, specimens from the Maldive Islands, Christmas Island, and the Macclesfield Bank. I said that this was the species I had previously called *Lamprometra protectus* (Lütken). I remarked that it is evident from Müller's original description and from the locality he gave (India—probably the Dutch East Indies) that it was this species that he had, and not that from the Red Sea. The latter must be known as *Lamprometra klunzingeri* (Hartlaub).

In 1923 I recorded a large number of specimens from various localities in the Indian Museum, and in 1934 I recorded additional specimens from Singapore and Christmas Island in the Raffles Museum, Singapore.

In 1934 Mortensen listed this species as occurring in Hongkong on the basis of previous records.

In 1936 Dr. Gislén recorded and gave notes on a specimen from Annam and on another from Cochinchina.

LAMPROMETRA PALMATA GYGES (Bell)

Plate 55, Figures 253–255

[See also vol. 1, pt. 1, fig. 344 (cirrus), p. 287; pt. 2, fig. 312 (proximal pinnules), p. 223; fig. 346 (distal pinnules), p. 229.]

Antedon tener Lütken, Mus. Godeffroy Cat., vol. 5, 1877, p. 100 (Port Denison, Queensland; Samoa; *nomen nudum*).—A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 117 (identity).

Antedon gyges Bell, Report Zool. Coll. H. M. S. *Alert*, 1884, p. 155 (specific formula), p. 160 (description; Thursday Island), pl. 12, figs. B, *a*, *b*.—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 49, 50, 55, 224, 225, 366, 379.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 40 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 714 (identity), p. 716 (credited to Australia by Carpenter); Crinoids of the Indian Ocean, 1912, pp. 31, 34 (identity).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 6 (identity).

Antedon tenera Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 180 (description; Queensland; Torres Strait).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 66 (detailed description; Queensland; Port Denyson; Torres Strait), p. 113 (in Göttingen Mus.).—A. H. Clark, Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 718 (identity); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (identity); Crinoids of the Indian Ocean, 1912, p. 37 (identity).

Antedon tenerea Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 39 (in key), p. 40 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).

Himerometra gyges A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra tenera A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Dichrometra gyges A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 441 (Australian tropical species occurring south to Thursday Island), p. 443 (range on east coast); Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 717 (known to Carpenter from Australia), p. 721 (occurs south to Cape York), p. 734 (in key), p. 771 (annotated synonymy; characters; Australian record; redescription of type; possibly a synonym of *Antedon tenera*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (*Antedon tenera* a synonym), p. 25 (includes *Antedon reginae* and *A. tenera;* Port Denison; Bowen; descriptions of specimens); Crinoids of the Indian Ocean, 1912, pp. 31, 34 (identity of previous records), p. 150 (synonymy; locality); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 311 (includes *tenera* and *reginae*), pl. 4, fig. 5 (specimen with 7 rays and 57 arms).—Alexander, Rec. Western Australian Mus., vol. 1, pt. 3, 1914, p. 108 (Inner bar, Shark Bay).—A. H. Clark, Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1915, pp. 223 ff. (detailed account of the distribution in Australia).

Dichrometra tenera A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Vid. Medd. Naturhist. Foren. København, 1909, p. 173 (Bowen; description of a specimen); Bull. Mus. Hist. Nat., Paris, 1911, p. 254 (Thursday Island); Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 440 (East Indian species occurring south to Perth and Bowen), p. 443 (range on east coast), p. 444 (range on west coast), p. 460 (localities; summary of previous records; descriptions of specimens; description of a 7-rayed specimen from ?Perth), pp. 465, 466 (association with other species); Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 718 (identity), p. 721 (occurs south to Bowen), p. 734 (in key), p. 771 (annotated synonymy; characters; Australian records; range); Proc. U. S. Nat. Mus., vol. 43. 1912, p. 398 (Western Australia); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 148 (synonymy; summary of previous records); Die Fauna Südwest-Australiens, vol. 4, Lief. 6, 1913, p. 311 (= *D. gyges*), p. 313 (correction of previous records).—H. L. Clark, Spolia Zeylanica, vol. 10, part 37, 1915, p. 85 (Ceylon; notes [see under *L. palmata*]), p. 93 (occurs at Ceylon).—Hartmeyer, Mitt. zool. Mus. Berlin, vol. 8, Heft 2, 1916, p. 235 (Western Australia, No. 5965; later determined as *D. gyges*).

Antedon articulata (Brit. Mus., MS.) A. H. Clark, Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 722 (= *Dichrometra tenera;* Port Essington, Queensland [error]); Crinoids of the Indian Ocean, 1912, p. 148 (= *Dichrometra tenera*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 32 (= *Lamprometra gyges;* Port Essington; North of Cape Hillsboro').

Lamprometra gyges A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 32 (published references to specimens in British Museum; localities represented); Unstalked crinoids of the *Siboga* Exped., 1918, p. 100 (in key; range).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 8 (collected by the Carnegie Exped., 1913), p. 23 (Mer; Mabuag, Torres Strait; notes; range; color), p. 192 and following (range), pl. 1, fig. 4 (colored), pl. 21, figs. 4, 5, pl. 22, fig. 3; Journ. Linn. Soc. (Zool.), vol. 35, 1923, p. 231 (Abrolhos Islands), p. 234 (Wooded Isle; characters).—McNeill and Livingstone, Rec. Australian Mus., vol. 15, 1926, p. 193 (Port Darwin).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641 (Hermit Island; Australia).—H. L. Clark, Great Barrier Reef Exped. 1928–29, Scientific Reports, vol. 4, No. 7, 1932, p. 201 (*Magneta* station XVII; or G. B. R. E. Gen Surv., A4).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 35 (Darwin, near Shell Island, 3–6 fathoms; Broome; False Cape Bossut; notes).

Lamprometra tenera A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).—H. L. Clark, Carnegie Inst. Washington Publ. 212, 1915, p. 104 (Mer; Marshall Islands).

Lamprometra protectus (part) A. H. Clark, Unstalked crinoids of the *Siboga* Exped., 1918, p. 100 (station 209).

Diagnostic features.—Though elongated, P_2 is not enlarged; the basal segments of the proximal pinnules are strongly carinate. In its typical form *Lamprometra palmata gyges* is easy to recognize, but it intergrades completely with *L. p. palmata.*

Description.—The centrodorsal is a moderately thick disk, with an uneven rather small bare dorsal pole, which has an irregular border and is slightly concave. The cirri are arranged in two or two and a partial third irregular rows on its sloping sides.

The cirri are XXX–XL, 20–30 (usually 20–25), about 15 mm. long and slender. The middle segments are slightly elongated, and the distal are somewhat compressed and bear a dorsal tubercle.

The radials are partially visible. The IBr_1 are entirely free laterally. The IBr_2 (axillaries) are pentagonal. The postradial series may divide four times. All the division series are 2. The post-radial series are in close lateral contact. The articulation between the axillaries and the preceding segments is sometimes somewhat tubercular. The sides of the postradial series are without protuberances.

The 32–43 arms are about 65 mm. long and are smooth and slender. The first brachials are almost completely united interiorly; they are a little longer exteriorly than interiorly. The second brachials are somewhat shorter. The first syzygial pair (composed of brachials 3+4) is squarish. The following three or four brachials are shorter and discoidal, and these are succeeded by about 27 rather short triangular brachials. The remaining brachials are short, bluntly wedge-shaped, finally becoming more squarish.

The first syzygy is between brachials 3+4, the second is usually between brachials 16+17 (occasionally between brachials 17+18), and the distal intersyzygial interval is 10–18 muscular articulations.

The length of the lower pinnules varies. P_2 is composed of about 25 elongated segments and is always longer than P_1. Both of these pinnules on the outer arms arising from each IIBr axillary are occasionally much longer than on the inner arms. On the outer arms the length of P_1 may reach 12 mm., and that of P_2 may reach 18 mm. The basal segments of these slender pinnules are flat and somewhat enlarged, and two of them are prominently or only slightly carinate. The three following pinnules are small. P_a and P_b are markedly smaller than the corresponding pinnules on the outer side of the arm (P_1 and P_2). The distal pinnules are 7 mm. long.

The disk is 10 mm. in diameter and is deeply incised. Sacculi are closely placed on the pinnules.

The color in alcohol is light gray-brown.

Color in life.—Dr. H. L. Clark says that most of the specimens are gray or brown of some shade and apparently unicolor, but a few of the lighter-colored ones seem to have had a broad whitish band on the arms in life.

Notes.—The preceding description is adapted from Hartlaub's original description of *Antedon tenera.*

The specimens from the Marshall Islands are variable. They are mostly referable to *gyges*, but some are fairly typical *palmata*, and some are intergrades. All have 30 arms, the six arms on each postradial series arranged in 2, 1, 1, 2 order, except one, which has 32 arms.

One of the specimens from Port Denison in the Hamburg Museum has about 43 arms, which are about 85 mm. long. The cirri are XLII, 24–27, 17 mm. long. P_2 is 18 mm. long, very slender, with 33 segments. On the innermost arms of the IIBr series (next the midradial line) P_2 is nearly as large as it is on the outermost arms of each postradial series, but elsewhere it is small. On some of the arms P_3 resembles P_2. The proximal pinnules are less carinate than usual.

A specimen from Bowen in the Hamburg Museum is smaller than the one just described. The two from Bowen in the Copenhagen Museum are typical and large.

Bell said that in *Antedon gyges*, which he described from a single specimen from Thursday Island, the centrodorsal is flattened, rounded, with the cirri arranged in three rows. The cirri are rather more than XL, rather more than 30, and are 21 mm. long. The fifth–tenth segments are longer than broad and those succeeding are shorter, and provided, first of all, with a convex dorsal edge; this narrows into a wide spinous protuberance, which becomes more and more spiny till the fairly well marked penultimate (i. e., opposing) spine is reached. The radials are completely concealed, and the IBr_1 are largely concealed. The IBr_2 (axillary) is triangular. There is a slight median conical protuberance in the line of junction between the IBr_1 and IBr_2. The IIBr and IIIBr series are 2, and in both cases there is a slight conical protuberance where the two ossicles meet, and in both cases also the more proximal of the two ossicles is in close lateral contact with its fellow. The 41 arms are about 80 mm. long. The first brachials are a little longer on their outer than on their inner side; along the latter they are in close contact with their fellow. As the second brachial is also longer without than within, there is a feebly marked diamond space interval. The first syzygial pair (composed of brachials 3+4) is nearly oblong, and has somewhat the appearance of a dice-box. For the next three or four brachials there is no wedge-shaped arrangement; at first feebly indicated, it rapidly becomes more marked; farther out it diminishes, and the terminal brachials are nearly oblong. The earlier brachials are flattened on their outer side. The first syzygy is between brachials 3+4, the next about between brachials 16+17, and the distal intersyzygial interval is 10 or 11 muscular articulations. Bell said that this species is at once to be distinguished from *Antedon* (*Dichrometra*) *flagellata* by the fact that the third is shorter than the first pinnule; of the first three pinnules the second is the longest. P_1 is but little shorter than P_2. The first three pinnules all have broad basal and elongated distal segments, but though longer than the next succeeding they are by no means remarkable in their length. The disk is 7.5 mm. in diameter and is incised. The arms are brownish flesh color; the peristome is very much darker; the cirri are much darker on their ventral than on their dorsal aspect.

In the key to the species of the *Palmata* group in the *Challenger* report (1888) Carpenter placed *gyges* under the headings two or more postradial axillaries (that is, two or more axillaries following the IBr axillaries), P_2 larger than P_3, postradial series in close contact laterally, cirri spiny, and P_2 considerably longer than P_3, IVBr series present, and the first syzygy always between brachials 3+4. It was paired with *palmata* (=*klunzingeri*) from which it was said to differ in having over 30 cirrus segments, P_1 not much larger than P_2 [Carpenter meant smaller instead of larger], and the lower brachials with flattened sides, whereas in *palmata* there are not over 25 cirrus segments, and P_1 is much smaller than P_2.

Hartlaub in his key to the species of the *Palmata* group (1891) placed *gyges* under the headings two or more postradial axillaries (that is, IIIBr, or IIIBr and IVBr series, present), P_2 longer than P_3, postradial series in lateral contact, lower pinnules of approximately equal size on all arms, spiny cirri, P_2 markedly longer than P_3, and the first syzygy always between brachials 3+4. It was paired with *palmata* (=*klunzingeri*) from which it was said to differ in having over 30 cirrus segments, P_1 not much shorter than P_2, and the lower brachials with flattened sides, whereas in *palmata* there are not over 25 cirrus segments, and P_1 is markedly smaller than P_2.

Hartlaub placed *tenera* (which he inadvertently called here *tenerea*) and *imparipinna* in a section characterized by having the lower pinnules larger on the outer arms arising from each IIBr series than on the inner, this section being contrasted with the section including *reginae*, *gyges*, and *palmata*, which was characterized by having the lower pinnules of approximately equal size on all the arms.

I examined the type specimen of *gyges* at the British Museum in 1910. The cirri are XXXV, 24–29 (usually 28), 20 to 25 mm. long. From the eleventh onward the segments are strongly carinate dorsally, or bear broadly rounded dorsal spines. There are 41 arms (four being broken off), 80 mm. long. P_2 is the longest pinnule, but it is slender, similar to P_1 but longer. P_3 is slender and weak, not nearly so long as P_1. The basal segments of these earlier pinnules are more or less carinate.

The specimen collected at Thursday Island by M. Lix is small, with about 40 arms.

According to Dr. H. L. Clark the specimen taken on the southwestern reef at Mer has 27 arms about 60 mm. long. P_2 is conspicuously the biggest pinnule on each arm but is only about 8 mm. long and consists of only 17 or 18 segments. None of the proximal pinnules are noticeably flagellate at the tip, as they are in the specimens from Mabuag. The cirri are XX, 18–24, with evident sockets for about 10 more cirri, which apparently have been very recently lost. Dr. Clark said that in this specimen the lower pinnules are stouter and the coloration is more variegated and much handsomer than in specimens from the Marshall Islands. In alcohol the blue and yellow tints have been lost, and the colors are dull reddish purple and reddish white.

Dr. Clark said that the single specimen from the Great Barrier reef is adult, more or less broken, but in fair condition, with arms 60–75 mm. long. It is of a deep purple-red color.

According to McNeill and Livingstone the specimen from Port Darwin is, in alcohol, dusky brown; the arms are about 65 mm. long.

Dr. H. L. Clark collected five young specimens at Darwin; 18 adults, large and small, at Broome; and 1 adult at False Cape Bossut. He said that this many-armed comatulid is common on the tropical coasts of Australia and its diversity of color and of arm length make it a very perplexing species. He was not all at convinced that several different species are not included under one specific name. On the other hand, he said, the supposed distinction between *gyges* and *protectus* is based upon a very variable character, and the line is hard to draw. His 24 specimens ranged from a young one with only 19 arms from 20 to 25 mm. long and the cirri XV, 14–15, up to fine adults with 45–51 arms 70 to 100 mm. long and with the cirri XXXVIII–XLVIII, 26–30.

The specimens from the Hamburg Southwest Australian Expedition stations 14 and 22 are both small and immature. That from station 22 has 33 arms 55 mm. long; P_2 is 12 mm. long.

The specimen presumably from the vicinity of Perth has seven radials and is described under the heading "Abnormal Specimen" (see p. 522).

Dr. H. L. Clark said that the two specimens from Wooded Isle, Abrolhos Islands, are light brown. The arms are about 100 mm. long, and their segments proximally are so closely apposed to each other that the basal part of the arm is noticeably smooth and regular. The cirri are XXX–XXXII, 25–30; one specimen shows 23 additional cirrus sockets. The cirri are less brown, grayer, than the calyx. In one specimen there can be distinguished along the dorsal side of each fully developed arm an inconspicuous longitudinal whitish line.

The specimen from *Siboga* station 209 has 20 arms and agrees perfectly with others at hand from the Marshall Islands.

Hartlaub said that this species varies greatly in the length of the lower pinnules. In the Göttingen specimen (from Queensland) these are strikingly small and fine, while in the Hamburg specimen (from Port Denison) they are of considerable length, and here they show, besides, the feature so characteristic of *Antedon imparipinna*, that is, the lower pinnules on the outer arms are longer than those on the inner. But both specimens agree in having the lower pinnules unusually slender, and this feature differentiates them from *imparipinna*, in which P_2 is rather stout and stiff. In this new species P_1 and P_2 are occasionally of the same length, and P_a may even be longer than P_b. Variation likewise affects the number of arms and the manner of division of the postradial series. There may be IVBr series present, as in the Hamburg specimen (from Port Denison), or these may be entirely absent, as in the Göttingen specimen (from Queensland).

Hartlaub said it is worthy of remark that this species is in general of a slender habitus, and of a uniform light gray-brown.

He noted that he had received a specimen from Torres Strait from Dr. P. H. Carpenter for examination. This specimen differed from the others described in having a flatter centrodorsal, the dorsal pole of which is larger and quite flat. Also the cirrus segments are somewhat more elongated. The ossicles of the proximal arm region are somewhat compressed laterally with an angular narrowed dorsal surface, this being more rounded in the other specimens. The color is light yellowish brown, but quite uniform as in the others. The lower pinnules are very fine and delicate, as in the specimen at Göttingen (from Queensland). There are 40 arms, no IVBr series being present. There are prominent keels on the basal segments of the lower pinnules.

Abnormal specimen.—The specimen presumably from the vicinity of Perth, Western Australia, is one of the most extraordinary comatulids I have ever seen. It has seven radials, which bear a total of 57 arms reaching a length of about 75 mm. The details of the postradial series are as follows, the enumeration beginning with the one just to the left of the anal interradial area and following the hands of the clock around the disk:

1. A normal postradial series, though a trifle undersized; it bears 8 arms about 70 mm. long; all the division series are 2.
2. Similar to the preceding, but with 6 arms, the two IIIBr series being external; all the division series are 2.
3. This postradial series arises from a radial displaced ventrally so that in their natural position the arms all lie over (ventral to) the arms arising from the radials on either side. The IBr_1 and IBr_2 are separated by an almost invisible suture. The right branch (as viewed ventrally) bears five arms, the extra axillary being on the innermost side next the left branch. The left branch bears six arms, the left IIBr series bearing two IIIBr series. The 11 arms are slightly smaller than the normal.
4. A normal postradial series bearing 9 arms. All the IIIBr series are developed.
5. This postradial series is slightly ventral to the preceding. It bears 10 arms, four on the right and six on the left branch, the extra axillaries on the latter being external.
6. This postradial series resembles the preceding. It bears nine arms, of which four are on the right branch and five are on the left branch. The extra axillary on the latter is on the side nearest the left branch—*i. e.*, external.
7. The radial bears four IBr ossicles arranged in two synarthrial pairs—that is, the IBr series is 4. There is one further division, two IIBr series being present, so that the total number of arms on this postradial series is 4. This IBr 4 series is the only division series not 2.

The disk bears two anal areas and two anal tubes, the one to the right being slightly the larger. Six of the converging ambulacral furrows are similar and approximately equal, but the postradial series displaced ventrally is supplied by an ambulacral groove that is practically equal to two of the others which divides immediately on leaving the peristome, so that apparently eight ambulacral furrows converge at the mouth. The cirri are XLV, 27–31, from 17 mm. to 20 mm. long, and slender. The longest proximal cirrus segments are slightly constricted centrally. The shorter distal segments have rounded dorsal spines which become more pointed terminally. On some arms P_1 is very nearly, or even quite, as stout basally as P_2, though it tapers more rapidly. The lower pinnules are all badly broken. In general this specimen agrees well with others at hand from the Marshall Islands.

Remarks.—*Lamprometra palmata gyges* is only an extreme variant of *L. palmata* characterized by the extreme slenderness of the lower pinnules. Complete intergradation occurs between typical *palmata* and typical *gyges*. *Lamprometra palmata gyges* is the dominant form in the Australian region and in Polynesia, but individuals occur in the Torres Strait region and in Tonga, Fiji, and the Marshall Islands that approach, and indeed are even in some cases more or less typical of, *L. p. palmata*. Similarly at Ceylon, in the Lesser Sunda Islands, at Celebes, and elsewhere within the area occupied by *L. p. palmata* occasional individuals are found that are quite indistinguishable from *L. p. gyges*.

Localities.—Ebon, Marshall Islands; Rev. B. G. Snow, April 14, 1877 [A. H. Clark, 1911; H. L. Clark, 1915] (9, U.S.N.M., 35248; M. C. Z., 61, 292).

Samoa [Lütken, 1877].

Suva reef, Fiji (1, M. C. Z., 293).

North of Cape Hillsborough, Queensland; H. M. S. *Rattlesnake* [A. H. Clark, 1913] (1, B. M.).

Port Denison, Queensland [Lütken, 1877; A. H. Clark, 1907, 1909]. Same [Hartlaub, 1891; A. H. Clark, 1907, 1911, 1912] (2, H. M.). Same [A. H. Clark, 1911] (1, U.S.N.M., 35261).

Bowen, Queensland [A. H. Clark, 1911, 1912] (1, H. M.). Same; Mus. Godeffroy, 1877 [A. H. Clark, 1909, 1911] (2, C. M.).

Queensland [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1911, 1912].

Thursday Island; 5–7 meters: H. M. S. *Alert* [Bell, 1884; P. H. Carpenter, 1888; Hartlaub, 1891; A. H. Clark, 1907, 1911, 1912, 1913, 1918; H. L. Clark, 1921] (1, B. M.).

Thursday Island; M. Lix, 1891 [A. H. Clark, 1911] (1, P. M.).

Mer, Murray Islands, Torres Strait; east flat; H. L. Clark, September 25, 1913 [H. L. Clark, 1915, 1921] (1, M. C. Z., 591). Same, south reef; H. L. Clark, September 26, 1913 [H. L. Clark, 1915, 1921] (1, M. C. Z., 593). Same, southwestern reef; H. L. Clark, September 26, 1913 [H. L. Clark, 1915, 1921].

Great Barrier Reef Expedition; *Magneta* station XVII; about one-quarter mile north of North Direction Island; 35 meters; sand, thick *Halimeda;* March 9, 1929 [H. L. Clark, 1932]. This specimen also bore the label G. B. R. E. General Survey, 24/4/29, A4.

Reef north of Mabuag, Torres Strait; Frank A. Potts, November 1913 [H. L. Clark, 1921] (4).

Mabuag, or Port Moresby, New Guinea; Frank A. Potts, November 1913 (1, U.S.N.M., 36280).

Torres Strait [Hartlaub, 1890, 1891; A. H. Clark, 1907, 1911, 1912]. Same (3, M. C. Z., 613).

Port Essington, Coburg peninsula, Northern Territory, Australia [A. H. Clark, 1911, 1913] (1, B. M.).

Port Darwin, Northern Territory, Australia; coral reef, shallow water; Surgeon Lieut. Comdr. W. E. J. Paradice, R. A. N.; H. M. S. *Geranium* [McNeill and Livingstone, 1926].

Darwin; near Shell Islands; 5–11 meters; sponge and alcyonarian bottom; H. L. Clark, July 1929 [H. L. Clark, 1938].

Broome, Western Australia; H. L. Clark, August and September 1929 and June 1932 [H. L. Clark, 1938].

False Cape Bossut; H. L. Clark, September 1929 [H. L. Clark, 1938].

Hamburg southwest Australian Expedition station 14; Shark Bay, Western Australia; Freycinet Reach, west of Middle Flat as far as the northern point of Heirisson Prong; 11–16 meters; bottom at first sandy, later rock with coral; September 12, 1905 [A. H. Clark, 1911] (1).

Hamburg southwest Australian Expedition station 22; Shark Bay, inner bar, on the crest of the bank; 6–9 meters; bottom coarse sand, and sand and seaweed; June 16, 1905 [A. H. Clark, 1911; Alexander, 1914] (1).

Hamburg southwest Australian Expedition; ?vicinity of Perth, Western Australia [A. H. Clark, 1911] (1).

Western Australia (refers to the three preceding records) [A. H. Clark, 1912; Hartmeyer, 1916] (3; one or more of these is Berl. M., 5965).

Hermit Island, northwestern Australia [A. H. Clark, 1929] (1, B. M.).

Wooded Isle, Abrolhos Islands, Western Australia [H. L. Clark, 1923] (2).

Australia; purchased from H. B. Preston [A. H. Clark, 1929] (2, B. M.).

Siboga station 209; anchorage off the southern point of Kabaëna Island, east of the entrance to the Gulf of Boni, Celebes; 22 meters; coarse sand; September 23, 1899 [A. H. Clark, 1918] (1, U.S.N.M., E. 405).

Erroneous locality.—Port Molle, Queensland [A. H. Clark, 1911]. This is the locality for Bell's *Antedon reginae* which was inadvertently considered as a synonym of the present species instead of a synonym of *Dichrometra articulata.*

Geographical range.—From the Marshall Islands, Samoa, and Fiji to northern Australia, south to Cape Hillsborough, Queensland, and the Abrolhos Islands and possibly Perth, Western Australia, and west to Kabaëna Island, to the eastward of the entrance of the Gulf of Boni, Celebes.

Bathymetrical range.—Littoral and down to 35 meters.

Habits.—Dr. Hubert Lyman Clark said that the single individual that he found at Mer Island, Torres Strait, was an active and very graceful swimmer.

History.—Prof. Christian F. Lütken first mentioned this form under the name of *Antedon tener* in 1877, merely including this name in a list of species with the localities Port Denison, Queensland, and Samoa.

It was described as a new species, *Antedon gyges,* and figured by Prof. F. Jeffrey Bell in 1884 from a single specimen collected by the *Alert* at Thursday Island.

In the *Challenger* report on the comatulids published in 1888 Dr. P. H. Carpenter criticized and corrected the specific formula for *Antedon gyges* published by Bell in

1884 and inserted the species in his key to the species of the *Palmata* group. He gave the locality as Torres Strait.

Dr. Clemens Hartlaub in 1890 described *Antedon tenera*, giving as the localities Queensland (Göttingen Museum) and Torres Strait. He described it in greater detail in 1891. He said that it is one of Lütken's manuscript species that has not previously been described. The material on which he based his final account consisted of a specimen from Queensland in the Göttingen Museum, one from Port Denison, Queensland, in the Hamburg Museum, and one from Torres Strait that he had received for examination from Dr. P. H. Carpenter. He gave notes on all these specimens. Unfortunately none of them were sufficiently well preserved to figure. Hartlaub inserted Bell's *gyges* in the key to the species of the *Palmata* group, on the basis of the characters used by Carpenter in 1888, but did not otherwise mention it.

In my first revision of the old genus *Antedon* published in 1907, *gyges* and *tenera* were placed in the new genus *Himerometra*, and in my revision of the family Himerometridae published in 1909 they were transferred to the new genus *Dichrometra*.

In a paper on the crinoids of the Copenhagen Museum published in 1909, I recorded as *Dichrometra tenera* two typical specimens from Bowen, Queensland, and gave the original reference to Lütken's manuscript name.

In a paper on the crinoids of the Paris Museum published in 1911, I recorded and gave notes on a specimen under the name *Dichrometra tenera* that had been collected at Thursday Island by M. Lix in 1891.

In my report on the crinoids of the Hamburg Southwest Australian Expedition published in 1911, as *Dichrometra tenera* I recorded and gave notes on three specimens, one from station 14, one from station 22, and one labeled "?vicinity of Perth." The last, a 7-rayed individual with 57 arms, was described in detail.

In my memoir on the recent crinoids of Australia published in 1911, I included *Dichrometra gyges* and gave notes on the type specimen, which I had examined at the British Museum in 1910. I said that this species is nearly related to *D. tenera*, of which it may eventually prove to be a synonym. I also included *D. tenera*, giving as the localities Torres Strait, Queensland, Bowen, and Port Denison, and adding that there is a dry specimen in the British Museum from Port Essington and a specimen from Thursday Island in the Paris Museum. In giving the distribution of the species I mentioned the Marshall Islands.

In a paper on the crinoids of the Berlin Museum published in 1912, I recorded *Dichrometra tenera* from Western Australia, the three specimens here referred to being those collected by the Hamburg Southwest Australian Expedition and first recorded in 1911.

In my paper on the crinoids of the Hamburg Museum published in 1912, two specimens of *Dichrometra gyges* were recorded from Port Denison and one was recorded from Bowen; notes were given on them. Hartlaub's *Antedon tenera* was included in the synonymy of *gyges* and, by an error, Bell's *Antedon reginae* was also included.

In my memoir on the crinoids of the Indian Ocean published in 1912, I included both *Dichrometra tenera* and *D. gyges*, giving all the localities from which the former had been recorded and adding Samoa from Lütken's original mention of the form, and giving the latter on the basis of Bell's specimen from Thursday Island only.

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In a supplement to my memoir on the crinoids collected by the Hamburg Southwest Australian Expedition, which was published in 1913, I changed the name *Dichrometra tenera* to *D. gyges*, added Port Molle to the list of known localities, and figured the specimen with 7 rays and 57 arms. Port Molle was added to the list of localities by error. This is the locality for Bell's *Antedon reginae*, which at the time was considered to be synonymous with *gyges* instead of with *Dichrometra articulata*.

In a revision of the family Mariametridae published in 1913 I transferred *gyges* and *tenera* to the new genus *Lamprometra*.

In a paper on the crinoids of the British Museum published in 1913, under the heading *Lamprometra gyges*, I gave notes on the type specimen of Bell's *Antedon gyges* and recorded specimens from Port Essington and from north of Cape Hillsboro' that were labeled *Antedon articulata*. Hartlaub's *Antedon tenera* was placed in the synonymy of *Lamprometra gyges*.

Dr. Hubert Lyman Clark in 1915 recorded a specimen of *Dichrometra tenera* from Ceylon. This is herein placed under *Lamprometra palmata palmata*, but it is only fair to Dr. Clark to say that it might equally well be placed under *L. p. gyges*.

Dr. Robert Hartmeyer in 1916 published a note saying that the specimens of *Dichrometra tenera* from Western Australia had been given the catalog number 5965 in the Berlin Museum, and that the author had later redetermined these as *D. gyges*.

In my report on the unstalked crinoids of the *Siboga* expedition I included *gyges* in my key to the species of *Lamprometra*, giving *Antedon tenera* Hartlaub as a synonym of *gyges* in a footnote. The specimen recorded as *L. protectus* (=*palmata*) from station 209 is herein considered as representing *L. p. gyges*.

In his memoir on the echinoderm fauna of Torres Strait published in 1921, Dr. H. L. Clark said that he had found only one comatulid at Mer that could be referred to *Lamprometra gyges* and mentioned other specimens that had been collected by Frank A. Potts on a reef north of Mabuag, Torres Strait, in November 1913, which I had identified as *gyges*. He gave notes on the specimen from Mer and figured it in colors, giving photographs of one of the specimens from Mabuag.

In 1923 Dr. Clark recorded and gave notes on two specimens of *Lamprometra gyges* from Wooded Isle, Abrolhos Islands (or Houtman's Rocks), Western Australia.

Frank A. McNeill and A. A. Livingstone in 1926 recorded and gave notes on a specimen of *Lamprometra gyges* from Port Darwin.

In 1929 I recorded one specimen from Hermit Island, northwestern Australia, and two from Australia that had been sent me for determination by the British Museum.

Dr. H. L. Clark in 1932 recorded a single specimen from the Great Barrier Reef Expedition, 1928–1929, which bore the labels "G. B. R. E. General Survey, 24/4/29, A4" and "*Dichrometra tenera* (Hartlaub), 1 spec. H. L. Clark, St. XVII." He said that this is apparently a specimen seen by him in Sydney in November 1929 and given Hartlaub's name, which is a synonym of *gyges*. He added that obviously one of the labels is wrong as to locality, and he believed the specimen came from A4.

In 1938 Dr. H. L. Clark recorded and gave notes on 24 specimens that he had collected in 1929 and 1932 at Darwin, Broome, and False Cape Bossut, recording them as *Lamprometra gyges*.

LAMPROMETRA KLUNZINGERI (Hartlaub)

Plate 55, Figure 256

[See also vol. 1, pt. 2, figs. 474, 475 (pinnule tip), p. 269.]

Comatula sp. Leuckart, Zeitschr. für organ. Physik, vol. 3, Heft 4, 1833, p. 387, footnote xx (Frankfort Mus.; collected by Rüppel).

Comatula leucomelas (Rüppel, MS.) Leuckart, Zeitschr. für organ. Physik, vol. 3, Heft 4, 1833, p. 387 (Red Sea; collected and named by Rüppell; Frankfort Mus.), p. 390 (2 openings to the digestive tube).—A. H. Clark, Amer. Nat., vol. 43, 1909, p. 255 (identified by Hartlaub as *Alecto palmata*); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 2 (MS. name of Rüppel; identified as *Alecto palmata*); Crinoids of the Indian Ocean, 1912, p. 2 (history; identity).

Comatula (*Alecto*) *palmata* (part) J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 261 (in Zool. Mus., Berlin, from the Red Sea through Hemprich and Ehrenberg; in Paris Mus., through Botta).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 30 (identity).

Comatula scita Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 208 (*nomen nudum*).—A. H. Clark, Bull. Mus. Hist. Nat., Paris, 1911, p. 246 (identified).

Comatula palmata von Martens, *in* von der Decken, Reise in Ost-Africa, vol. 3, 1869, p. 129 (Red Sea).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 3 (notice of preceding record).

?*Comatula multiradiata* von Graff, Das Genus *Myzostoma*, 1877, p.—(Red Sea; myzostomes); *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, p. 32 (same).

Antedon palmata P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 23 (arm structure), p. 29 (listed as an *Antedon*), p. 45 (2 palmars on 2 distichals occur in this species).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 733 ff. (discussion of Bell's method of formulation and corrected formula).—von Graff, *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, pp. 13, 18, 32 (Red Sea; myzostomes).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 35 (in part), 44 (in part), 54 (in part), 55 (in part), 208 (in part), 213 (in part), 224, 226, 366 (in part), 379 (Red Sea, but not Ceylon = *L. palmata*).—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, pp. 37, 40 (in key), p. 49 (synonymy, in part; Red Sea; Djeddah; other localities refer to *L. palmata*), pl. 3, fig. 27 (from one of Rüppel's specimens in Senckenb. Mus. labeled *Antedon leucomelas*).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—Chadwick, Journ. Linn. Soc. (Zool.), vol. 31, 1908, p. 47 (coral reef of Misharif Island, Khor Dongola; between tide marks at Suez).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 5 (recorded by Chadwick from Red Sea), p. 6 (Bell's record from southeast Africa is *Stephanometra indica*); vol. 43, 1912, p. 385 (of Hartlaub, 1891, 5 from Red Sea collected by Hemprich and Ehrenberg, and the others from Red Sea, are this species; the record from Singapore refers to *L. palmata*); Crinoids of the Indian Ocean, 1912, pp. 34, 37, 40, 41 (identity of previous records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 85 (of Bell, 1888, and Thurston, 1894=*Stephanometra indica* + *L. palmata;* of Bell, 1902=*Himerometra sol*).

Antedon sp. (*Palmata* group) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 224 (Aden; Red Sea; common).

Antedon klunzingeri Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 175 (description; Koseir); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 46 (detailed description; Koseir), pl. 2, figs. 22, 25; Bull. Mus. Comp. Zool., vol. 27, p. 1912, 152 (comparison with *Antedon subtilis*).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 4 (history); vol. 43, 1912, p. 399 (identity); Crinoids of the Indian Ocean, 1912, p. 37 (identity); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641.

Antedon spec. (P. H. Carpenter, MS.) Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 51 (notes).

Antedon leucomelas (Rüppel, MS.) Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 51 (identity), pl. 3, fig. 27.

Himerometra klunzingeri A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra palmata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Antedon imparipinna Chadwick, Journ. Linn. Soc. (Zool.), vol. 31, 1908, p. 46 (Suez Bay; Suakim Harbor; characters of the specimens; colors in life; commensal polynoid).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 5 (identity).

Dichrometra klunzingeri A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Amer. Nat., vol. 43, 1909, p. 255 (described from Koseir; not found by Chadwick); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 9 (northeast coast of Africa), p. 27 (synonymy; Koseir; Ras-el-Millan; littoral); Crinoids of the Indian Ocean, 1912, p. 37 (identity), p. 149 (synonymy; localities).

Dichrometra palmata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Amer. Nat., vol. 43, 1909, p. 255 (recorded from Red Sea by Chadwick); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 5 (=*Antedon palmata* Chadwick), p. 9 (northeast coast of Africa), p. 14 (Red Sea to India), p. 27 (synonymy; localities; range; localities east of Red Sea refer to *L. palmata*); Notes Leyden Mus., vol. 33, 1911, p. 187 (Djeddah; description of the specimen); Bull. Mus. Hist. Nat., Paris, 1911, p. 246 (=*Comatula scita*), p. 253 (Red Sea; remarks); Crinoids of the Indian Ocean, 1912, pp. 1, 30, 34, 37, 41 (identity of previous records), p. 148 (synonymy; records of localities refer to *L. palmata;* remarks); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 24 (Gimsah Bay; description of the specimen); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 382 (cotype from the Red Sea in U. S. N. M.), pp. 383, 385 (identity of previous records), p. 385, footnote 3 (discrepancy in Müller's description explained), p. 398 (localities; detailed descriptions of the specimens; remarks).—Hartmeyer, Mitt. zool. Mus. Berlin, vol. 8, Heft 2, 1916, p. 235 (Um el Jerman; Ras el Millan, No. 5603; Red Sea, Hemprich and Ehrenberg, No. 1058; ?locality, No. 5331).

Comatula cucomelas A. H. Clark, Amer. Nat., vol. 43, 1909, p. 254 (for *leucomelas;* MS. name of Rüppel).

Alecto palmata A. H. Clark, Amer. Nat., vol. 43, 1909, p. 254 (von Marten's record); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 3 (history; recorded by von Martens from east Africa); vol. 43, 1912, p. 383 (explanation of Müller's composite), p. 383, footnote (Müller's specimens from India and Zamboanga are *L. palmata*), p. 385, footnote (discrepancy in original description explained).

Dichrometra protectus A. H. Clark, Amer. Nat., vol. 43, 1909, p. 255 (recorded from Red Sea by Chadwick); Proc. U. S. Nat. Mus., vol. 40, 1911, p. 5 (=*Antedon imparipinna* Chadwick from the Red Sea), p. 9 (northeast coast of Africa), p. 14 (Red Sea), p. 26 (Suez Bay; Suakim Harbor); Crinoids of the Indian Ocean, 1912, p. 41 (=*Antedon imparipinna* Chadwick, 1907).

Lamprometra klunzingeri A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641 (correct application of the name); Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 558 (Abu Zanima); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 87 (listed), p. 89 (*Mabahiss* Sta. 56; notes; range), p. 100 (range), p. 104.

Lamprometra leucomelas A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Lamprometra palmata A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 33 (Red Sea; Muscat; does not occur farther east than Arabia); Unstalked crinoids of the *Siboga* Exped., 1918, p. 100 (in key; range).—Mortensen, Trans. Zool. Soc. London, vol. 22, pt. 1, 1926, p. 127 (Km. 146; Port Taufiq; Suez Gulf; notes).—Fox, *in* Mortensen, Trans. Zool. Soc. London, vol. 22, pt. 1, 1926, p. 127, footnote (color in life).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 20.— A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 89 (identity).

Lamprometra scita A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

?*Lamprometra klunzingeri* A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641 (Zanzibar).

Diagnostic features.—Though elongated, P_2 is not enlarged; P_3 is similar to P_2, and usually not much shorter; the basal segments of the proximal pinnules are not at all, or are only very slightly, carinate.

Description.—The centrodorsal is a moderately thick disk, with a flat or sometimes slightly concave dorsal pole. The cirri are arranged in one or several irregular marginal rows.

The cirri are XX–XXX, 20–25, about 16 mm. long. The majority of the segments are longer than broad. The outer part of the cirri is a little compressed laterally. The segments in the outer half of the cirri bear blunt dorsal spines.

The radials are visible in the interradial angles. The IBr_1 are short and broad and are often only slightly united laterally. The IBr_2 (axillaries) are short, broadly pentagonal or almost triangular. The postradial series divide three times. The IIBr and IIIBr series are 2. The IIIBr series arise as a rule only on the outer side of the IIBr axillaries. Slight synarthrial tubercles are present. There are either no, or only very slight, protuberances on the outer sides of the postradial series.

There are not more than 31 arms, which are 110 mm. long. The arms have a smooth dorsal surface and are very slender. The second brachials are a little longer than the first. The first syzygial pair (composed of brachials 3+4) is approximately squarish but a little broader than long. This is followed by a few short discoidal brachials, which are succeeded by moderately short almost triangular brachials, of which from 12 to 14, though sometimes more, may be present. The following brachials are more bluntly wedge-shaped, finally becoming more oblong.

The first syzygy is between brachials 3+4, and the second is from between brachials 9+10 to between brachials 16+17. The succeeding syzygies occur at intervals of two to four muscular articulations, sometimes also in groups of two.

The pinnules of the first pair are very delicate and small and taper rapidly after the three or four first basal segments, which are broadened. The pinnules of the following pair (P_2 and P_b) are markedly larger and measure about 9 mm. They are moderately slender and are composed of about 20–25 segments, which may be a little longer than broad. The pinnules of the third pair (P_3 and P_c) are as a rule likewise markedly longer than those of the first pair (P_1 and P_a), although only three-fourths as long as P_2 and P_b. The pinnules of the three following pairs are considerably smaller. The length of the succeeding pinnules increases and reaches about 9 mm. The basal segments, especially the third and fourth of the four lowest pinnules, are moderately broad and often a little carinate.

The disk is 15 mm. in diameter and is strongly incised. There are fine calcareous rods in the marginal lappets and tentacles of the pinnules. Sacculi are thickly placed on the pinnules. The color is a uniform dark blackish brown.

The preceding description is adapted from Hartlaub's account of five specimens in the Berlin Museum from the Red Sea collected by Hemprich and Ehrenberg. One of these was later transferred to the Göttingen Museum.

Notes.—In one of the specimens from Suez Bay the dorsal surface of the centrodorsal is simply flattened. There are 27 arms. The second syzygy occurs from between brachials 18+19 to between brachials 20+21, and the distal intersyzygial interval is 9 or 10 muscular articulations. Another specimen from Suez Bay is uniform purplish black.

Mortensen said that one of the specimens from Port Taufiq is very young, and the specimen from the Gulf of Suez (station R. 6) is in very poor condition; the identification of these two specimens, therefore, is not beyond doubt. H. Munro Fox said that in life this species is black. On immersion in fresh water a reddish-brown pigment dissolves out instantaneously. His observations were based upon the specimens recorded by Mortensen.

The specimen from Gimsah Bay is a fine example of the species, with 29 arms 120 mm. long and the cirri XXVII, 21–24. The dorsal pole of the centrodorsal is 3 mm. in diameter and is slightly concave.

In the specimen from Um-el-Jerman the centrodorsal is thick discoidal, with a flat dorsal pole 2.5 mm. in diameter. The cirrus sockets are arranged in two irregular closely crowded marginal rows. The cirri are XIV, 24–25 (usually the former), and are 20 mm. long. The longest proximal segments are about one-third again as long as broad. The distalmost 8 or 10 segments are slightly broader than long and bear a well-marked median dorsal keel, which on the outermost shortens into a small tubercle. There are 30 arms 115 mm. long. The division series are well rounded dorsally and well separated laterally. The arms are perfectly smooth dorsally. P_1 is 13 mm. long and is composed of 28 segments. It tapers rather rapidly for the first four segments, then becoming more slender and tapering gradually to the tip. The first segment is about twice as broad as long, and those following gradually increase in length so that the fourth is about as long as broad; the segments beyond the seventh are about one-third again as long as broad, and the terminal are half again as long as broad. The first three segments have their distal angles slightly cut away, but this feature is absent from those following. P_2 is 14 or 15 mm. long, with 30 segments, slightly stouter and stiffer than P_1 and tapering more evenly from the base, though otherwise exactly resembling it. P_3 is 11 mm. long, with 23 segments, of which the distal, as in P_2, are about twice as long as broad. The pinnule is about as stout basally as P_1 but tapers very evenly and gradually. It is considerably more slender than P_2. P_4 is 6.5 mm. long, with 17 segments, and is essentially like P_3. P_5 is 5.5 mm. long, with 16 segments, and resembles P_4. The pinnules following resemble P_5, later becoming longer and slenderer. The distal pinnules are 8 to 9 mm. long, very slender, with 19 to 21 segments. This specimen is dull flesh color, with broad bands of black on the arms. The dorsal half of the cirri is dull flesh color, and the ventral half is black.

The specimen from Kosseir was described by Dr. Clemens Hartlaub as a new species, *Antedon klunzingeri*, as follows: The centrodorsal is approximately hemispherical and is entirely covered with cirrus sockets. Only three cirri are present. The consist of about 20 segments and are 11 mm. long. They have a smooth surface. The segments from the fifth to about the twelfth are longer than broad. The number of the cirri, judged from the vestiges present, was about XXX. The radials are partially visible. The IBr_1 are entirely free laterally. The IBr_2 (axillaries) are pentagonal, not twice as long as the IBr_1, with moderately sharp angles and slightly concave distal edges. The division of the different postradial series is irregular. None divides more than three times, and the number of arms on a single postradial series does not exceed four. One of the postradial series bears two arms and another three. The articulation between the axillaries and the preceding ossicles is entirely smooth, and the outer edges of the postradial series are smooth. The ossicles immediately following each axillary are only partially united interiorly. There are 17 arms 100 mm. long with a smooth dorsal surface and composed of moderately short brachials. The first brachials are shorter than the second, which is a little longer exteriorly than interiorly. The first syzygial pair (composed of brachials 3+4) is larger and almost squarish. From the ninth brachial onward there are some almost triangular brachials, which very soon pass over into short more cylindrical brachials. These last toward the ends of the arms become more squarish and finally longer than broad. The first syzygy is between brachials 3+4, the second between brachials 15+16, and the distal intersyzygial interval is mostly 8 to 11 muscular articulations. Arms arising from IBr axillaries have the second syzygy between brachials 9+10, and those succeeding at intervals of at first 4 but later 7–9 muscular articulations.

P_1 is about 8 mm. long and is somewhat slenderer and shorter than P_2, which is about 10 mm. long and is composed of 15–20 smooth segments, of which the majority are elongated. P_3 is of the same size as P_1. Then follows the shortest pinnule, after which the length of the pinnules again increases, reaching about 13 mm. The maximum length of the distal pinnules is greater than the length of the pinnules of the second pair (P_2 and P_b). In arms arising from a IIBr or IIIBr axillary the relative sizes of the lower pinnules is somewhat less than those given, which are taken from arms arising from a IBr axillary, and the difference in size between P_1 and P_2 is less pronounced. The lower pinnules on the outer side of the arms, especially P_2, are longer than the corresponding pinnules on the inner side. The relatively slender structure of the lower pinnules is characteristic. The disk is lacking. Sacculi are thickly set on the pinnules. The color is dirty white, with about seven broad bands of light brown on the arms.

Hartlaub said that his, as it appeared to him undoubtedly new, species, has a certain similarity to *Heterometra savignyi* in the form of the centrodorsal and in the lateral freedom and the irregular division of the postradial series. In addition to these features, the entire absence of synarthrial tubercles is noteworthy, and also the entirely smooth surface of the arms and the relatively small size of the lower pinnules. The distal pinnules, on the other hand, are long and give the arm a featherlike appearance. Unfortunately only three cirri are preserved, and none of these appear to be fully developed.

In the specimens from Misharif Island, according to Chadwick, the central portion, as far as and including the proximal brachials, is in alcohol dirty white, and the arms are alternately and broadly banded with the same color and dark brownish gray. The dorsal and ventral faces of the cirri show the same contrast of color.

In the four specimens from Suakim Harbor, especially the larger ones, the dorsal surface of the centrodorsal is concave. There are 21, 21, 26, and 33 arms. In several of the specimens syzygies occur between brachials 9+10 and 14+15, and in several of the arms of the larger specimens the second syzygy is between brachials 22+23.

The specimen from Ras-el-Millan has 24 arms 90 mm. long and resembles the one from Um-el-Jerman. As is always the case in this species, the IIIBr series are externally developed.

Hartlaub said that the specimen from Jiddah and another from the Red Sea in the Berlin Museum (No. 2019) differ from the specimens from the Red Sea collected by Hemprich and Ehrenberg in being of much coarser structure, having especially a much thicker centrodorsal. The specimen from Jiddah is besides noteworthy for the considerable length of the pinnules of the second pair (P_2 and P_b). In this it recalls the two from the Red Sea labeled *Antedon* spec. by Carpenter, which in their much more delicate build are nearer the typical specimens.

The specimen from the Red Sea (No. 2019) I examined at the Berlin Museum in 1910. It has 30 arms 135 mm. long. The centrodorsal is thick discoidal, with slightly sloping sides and the flat dorsal pole 4 mm. in diameter; the cirrus sockets are arranged in three closely crowded marginal rows. The cirri are 17 to 20 mm. long and composed of 24 or 25 segments, of which the outer are carinate; the longer proximal segments are slightly longer than broad, and the short distal segments are slightly broader than long.

Hartlaub figured one of the two specimens of *Antedon leucomelas* Rüppel sent him from the Senckenberg Museum. He said that the color was light brown, so that the species name given by Rüppel seems scarcely understandable. The color of comatulids, however, often changes very greatly after long preservation in alcohol.

At the Berlin Museum in 1910 I examined three of the specimens described by Hartlaub. One was small and badly broken, and the other two had 30 arms 110 mm. long. These had been brought from the Red Sea by Hemprich and Ehrenberg.

The specimen collected by M. Botta in the Red Sea in 1836 is of medium size, and has about 30 arms.

Of the two specimens from the Red Sea collected by M. Jousseaume, one is of medium size and the other is small.

Hartlaub mentioned two specimens in the Berlin Museum that had been labeled *Antedon* spec. by Dr. P. H. Carpenter. They are distinguished by their delicate postradial series and strikingly long lower pinnules, though in their other features they show so very much the character of the present species that he could not separate them from it.

The specimen from the Red Sea in the British Museum is a fine example of the species.

The specimen from Muscat has 36 arms and the cirri XLV, 22–25.

The specimen from Zanzibar is small, but it appears to be of this species.

The specimen from Dar-es-Salaam consists of fragments only.

Hartlaub said that in this species the length of the lower pinnules, as well as the extent to which the postradial series are separated from each other, appears to be subject to variation. The same is true of the general habitus, which is sometimes stout, sometimes much slenderer, as in the specimens upon which Müller's description was based (that is, the specimens from the Red Sea collected by Hemprich and Ehrenberg).

Localities.—Suez; between tide marks; C. Gordon Logan, Esq. [Chadwick, 1908; A. H. Clark, 1911].

Suez Bay; Cyril Crossland [Chadwick, 1908; A. H. Clark, 1911].

Cambridge Expedition to the Suez Canal, 1924, station Km. 146; stretch of canal from Little Bitter Lake to Suez, at Canal Company's Signal Station; October 31, 1924 [Mortensen, 1926; Fox, 1926].

Cambridge Expedition to the Suez Canal, 1924; Port Taufiq [Mortensen, 1926; Fox, 1926].

Cambridge Expedition to the Suez Canal, 1924; station R. 6; eastern shore of Suez Gulf, 8 kilometers south of the quarantine pier; November 6, 1924 [Mortensen, 1926; Fox, 1926].

Gimsah Bay, African coast of the Gulf of Suez; Dr. R. Hartmeyer [A. H. Clark, 1912] (1, H. M.).

Abu Zanima, Gulf of Suez; Capt. R. B. S. Sewell, I. M. S., July 1916 [A. H. Clark, 1932] (1, I. M.).

Um-el-Jerman, Gulf of Suez; Dr. R. Hartmeyer [A. H. Clark, 1912 (as Um-el-Terman); Hartmeyer, 1916] (1, U.S.N.M., 35769 [previously Berl. M., 5604]).

Kosseir (or Koseir), Egypt [Hartlaub, 1890, 1891, 1895; A. H. Clark, 1909, 1911, 1912].

Misharif Island, Khor Dongola; coral reef; Cyril Crossland [Chadwick, 1908; A. H. Clark, 1911] (1, U.S.N.M., 35224).

Suakim (or Suakin) Harbor, Sudan; Cyril Crossland [Chadwick, 1908; A. H. Clark, 1911].

Ras-el-Millan; littoral; Dr. Robert Hartmeyer [A. H. Clark, 1911, 1912; Hartmeyer, 1916] (1, Berl. M., 5603 [5602]).

Jiddah (Djeddah), eastern coast of the Red Sea; J. A. Kruyt [Hartlaub, 1891; A. H. Clark, 1911] (1, L. M.).

Aden [P. H. Carpenter, 1888].

Red Sea; Rüppel [Leuckart, 1833; von Graff, 1877, 1884; P. H. Carpenter, 1888; Hartlaub, 1891; Chadwick, 1908; A. H. Clark, 1909, 1911, 1912].

Red Sea; Hemprich and Ehrenberg [J. Müller, 1849; von Martens, 1869; P. H. Carpenter, 1884, 1888; Hartlaub, 1891; Chadwick, 1908; A. H. Clark, 1911, 1912] (3, Berl. M., 1057, 1058 [1059], 2454).

Red Sea; M. Botta, 1836 [A. H. Clark, 1911] (1, P. M.).

Red Sea; M. Jousseaume, 1893–1898 [A. H. Clark, 1911] (2, U.S.N.M., 35247; P. M.).

Red Sea; Herr Umlauff [Hartlaub, 1891; Chadwick, 1908; A. H. Clark, 1911, 1912] (1, Berl. M., 2019).

Red Sea [A. H. Clark, 1913] (1, B. M.).

Mabahiss station 56; South Arabian coast (lat. 22°12′42″ N., long. 59°51′18″ E.); 421 meters; green mud; November 4, 1933 [A. H. Clark, 1936] (1, B. M.).

Muscat [A. H. Clark, 1913] (1, B. M.).

?Zanzibar; Dr. Cyril Crossland [A. H. Clark, 1929] (1, B. M.).

?Dar-es-Salaam, Tanganyika Territory [A. H. Clark, 1912] (fragments, Berl. M., 4169).

No locality [A. H. Clark, 1912; Hartmeyer, 1916] (2, Berl. M., 5331).

Geographical range.—Red Sea and eastward to Muscat, on the western coast of the Gulf of Oman. The southern limit of the range has not been determined, the records from Zanzibar and Dar-es-Salaam being based on doubtfully correct determinations.

Bathymetrical range.—Littoral; all the known specimens but one have been taken in shore collecting, some of them between tide marks. The single exception is a very small example brought up in a dredge haul by His Egyptian Majesty's Steamship *Mabahiss* from 421 meters. There is a possibility that this individual was intercepted by the dredge as it was swimming at or near the surface.

History.—This species was first mentioned by Prof. Friedrich Sigismund Leuckart in 1833 as *Comatula* sp. and as *Comatula leucomelas* Rüppel, MS., the specimens to which he referred having been collected in the Red Sea and named by Dr. Eduard Rüppel.

In 1849 Prof. Johannes Müller, under *Comatula* (*Alecto*) *palmata*, listed specimens in the Berlin Museum that had been collected in the Red Sea by Friedrich Wilhelm Hemprich and Christian Gottfried Ehrenberg, and others in the Paris Museum collected by Paul Émile Botta in 1836. None of these specimens had been mentioned in the original description of *Alecto palmata* published in 1841.

Félix Dujardin and H. Hupé in 1862 gave a list of unpublished museum names that the latter had found with specimens in the Paris Museum. Among these names was *Comatula scita*, which had been applied to this species.

In 1869 Prof. Eduard von Martens mentioned this form, as *Comatula palmata*, from the Red Sea.

Prof. Ludwig von Graff in 1877 described the myzostomes from a specimen from the Red Sea, which he listed as ?*Comatula multiradiata*, repeating this record in 1884.

In 1879 Dr. P. H. Carpenter identified Müller's *palmata* as a species of the genus *Antedon* as he understood it and compared the structure of its division series with that of the division series of other comatulids.

In October 1882, Prof. F. Jeffrey Bell published a specific formula for *Antedon palmata*, which was emended by Carpenter in March of the year following.

The *Antedon palmata* of Carpenter's report on the comatulids of the *Challenger* expedition published in 1888 was for the most part the present species, but in the list of principal localities Carpenter included both the Red Sea and Ceylon, showing that he confused this species with the preceding as Müller had done in 1849. He said that there are always two and sometimes three axillaries beyond the IBr axillaries. In the key to the species of the *Palmata* group *palmata* was paired with *gyges;* the former was said to have not over 25 cirrus segments and P_1 much smaller than P_2, while *gyges* was said to have over 30 cirrus segments, P_1 not much larger (that is, smaller) than P_2, and the lower brachials with flattened sides. Carpenter said that *palmata* is common at Aden and in the Red Sea. There is no other mention of its occurrence at Aden, and no specimens have ever been definitely recorded from that city.

In his memoir on the comatulids of the Indian Archipelago published in 1891, Dr. Clemens Hartlaub described in detail under the name *Antedon palmata* five specimens in the Berlin Museum that had been brought from the Red Sea by Hemprich and Ehrenberg and previously recorded by Müller in 1849. He called these the type ("original") specimens in spite of the fact that the specimen (or specimens) mentioned in the original description had been brought by Dr. D. F. Eschricht from "Indien." In addition to these specimens he gave notes on two in the Berlin Museum that had been labeled *Antedon* spec. by Carpenter, another in the same museum from the Red Sea, and one from Djeddah (Jiddah) in the Leyden Museum. Two of the specimens in the Senckenberg Museum at Frankfurt-am-Main that had been collected by Rüppel and by him labeled *Antedon leucomelas* had been sent to Hartlaub for study, and one of these he figured. The other specimens he mentioned—from Singapore, the Tonga Islands, and Ceylon—are *L. palmata palmata.* Hartlaub described as a new species *Antedon klunzingeri*, which was based on a single specimen from Koseir (Kosseir), on the Red Sea coast of Egypt. In his key to the species of the *Palmata* group, *klunzingeri* was paired with the very different (*Cenometra*) *bella*, and in the description he said that it resembled *bella* in the irregular division of the postradial series. This, however, is merely a juvenile feature.

In my first revision of the old genus *Antedon* published in 1907, *palmata* and *klunzingeri* were referred to the new genus *Himerometra.*

In 1908 Herbert Clifton Chadwick recorded and gave notes on several specimens from Misharif Island and one from Suez that he called *Antedon palmata,* and one from Suez Bay and four from Suakim Harbor that he called *Antedon imparipinna.*

In my revision of the family Himerometridae published in 1909, *klunzingeri* and *palmata* were referred to the new genus *Dichrometra.*

In a paper on the crinoids of the Leyden Museum published in 1911 I gave notes on the specimen from Djeddah previously recorded by Hartlaub, which I had examined in 1910.

In my memoir on the crinoids of the coasts of Africa published in 1911, I included *Dichrometra protectus* (=*palmata*), repeating Chadwick's records for *Antedon imparipinna, D. palmata* (the present species), giving Chadwick's records and also "Red Sea," and *D. klunzingeri,* with the localities Koseir and Ras-el-Millan, the latter being taken from a specimen in the Berlin Museum. Under *D. palmata* was included *Comatula scita* as a synonym. This species was said to range eastward to the Tonga Islands, following Hartlaub.

In a paper on the crinoids of the Paris Museum published in 1911, I recorded and gave notes on a specimen of *Dichrometra palmata* from the Red Sea collected by M. Botta in 1856 (in reality 1836), and on two specimens from the Red Sea collected by M. Jousseaume in 1893–1898.

In a paper on the crinoids in the Berlin Museum published in 1912, I recorded and gave notes on eight lots of specimens from Um-el-Jerman, Red Sea, without further data (four lots, three collected by Hemprich and Ehrenberg), Ras-el-Millan, Dar-es-Salaam, and an unknown locality. The record from Dar-es-Salaam, which was said to be on the Red Sea, was based on fragments. Hartlaub's *Antedon klunzingeri* was said to be identical with this species, which was given as *Dichrometra palmata.*

I noted that Hartlaub called attention to the fact that Müller in describing *Alecto palmata* (see page 501) gave the number of arms as 35–40, whereas true *palmata* has but 30. Müller's description of *palmata* (that is, the description published in 1849) was partly (in reality wholly) based upon specimens of *Dichrometra protectus* (=*Lamprometra palmata*), a 40-armed species, and he seems to have taken the arm number from these. I remarked that Müller's specimens of *palmata* from India and from Zamboanga are both representatives of *protectus* (=*palmata*).

In a paper on the crinoids of the Hamburg Museum published in 1912, I recorded and gave notes on a specimen from Gimsah Bay that had been collected by Dr. Robert Hartmeyer.

In my memoir on the crinoids of the Indian Ocean published in 1912, I listed the Red Sea, Suez Bay, and Suakim Harbor among the localities for *Dichrometra protectus,* following Chadwick. I recorded specimens of *D. palmata* from Gwada, Baluchistan, Snod Island in the Mergui Archipelago, and ?Celebes, and gave as the localities from which the species was previously known "India," Red Sea, Djeddah, coral reef at Misharif Island, between tide marks at Suez, Muscat, Ceylon, Java, Singapore, Bougainville Island, and Tonga. I said that the specimens recorded agree well with a specimen collected by the German steamer *Gazelle* at Bougainville Island and identified by P. H. Carpenter, and further that they were compared directly with Professor Müller's types, which are in the Berlin Museum. The specimens referred to as Müller's types are those from the Red Sea collected by Hemprich and Ehrenberg. The actual type of *palmata*, however, is the specimen brought by Dr. D. F. Eschricht from "Indien." I listed *D. klunzingeri*, with the localities Koseir and Ras-el-Millan.

In the revision of the family Mariametridae published in 1913, I referred to the new genus *Lamprometra* the nominal species *klunzingeri*, *leucomelas*, *palmata*, and *scita*.

In a paper on the crinoids of the British Museum published by me in 1913, specimens of *Lamprometra palmata* were recorded from the Red Sea and from Muscat, and notes on them were given. It was stated that Carpenter's record of this species from Ceylon was based upon an example of *L. protectus* (=*palmata*) and that *L. palmata* (=*klunzingeri*) does not occur further eastward than Arabia.

In my report upon the unstalked crinoids of the *Siboga* expedition published in 1918, I included *palmata* in my key to the species of the genus *Lamprometra*, including as synonyms *Comatula leucomelas*, *C. scita*, and *Antedon klunzingeri* and giving as the range the Red Sea and eastward to Muscat.

In 1926 Dr. Th. Mortensen recorded five specimens that had been collected by the Cambridge Expedition to the Suez Canal, 1924, and at the same time H. Munro Fox published a note on the color in life and the solubility of the pigment in fresh water.

In 1929, in a paper on a collection of crinoids in the British Museum, I recorded as ?*Lamprometra klunzingeri* a small specimen from Zanzibar. Under the heading *Lamprometra palmata* I pointed out that the present species must be known as *L. klunzingeri* (see page 516).

In 1932 I recorded a specimen from Abu Zanima in the collection of the Indian Museum, Calcutta.

LAMPROMETRA sp.

Lamprometra sp. Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 194 (pentacrinoid).

Dr. Gislén here refers to the pentacrinoid described in Part 2, pp. 518–520.

Genus DICHROMETRA A. H. Clark

Alecto (part) J. Müller, Monatsb. preuss. Akad. Wiss., 1841, p. 186.

Comatula (part) J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 257.

Antedon (part) P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 186.

Himerometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356.

Dichrometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 12 (diagnosis; genotype *Alecto flagellata* J. Müller, 1841); Amer. Nat., vol. 43, 1909, p. 254 (represented in Red Sea); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 144 (compared with *Mariametra*), p. 176 (referred to the Mariametrinae); Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 129 (characteristic of the Japanese fauna; significance); Die Fauna Südwest-Australiens, vol. 3, Lief, 13, 1911, p. 439 (2 peculiar Australian species); Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 732 (in key), p. 734 (key to the Australian species), p. 769 (original reference; characters; range); Crinoids of the Indian Ocean, 1912, p. 9 (possesses additional species in Australia), p. 11 (represented in Ceylon and Red Sea regions), p. 12 (represented in southeast African region), p. 17 (significance of the conditions in this genus in southern Japan), p. 57 (in key), p. 143 (original reference; type); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 141 (in family Mariametridae), p. 144 (synonymy; genotype; range; depth; included species), p. 142 (in key); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 98 (in key; range), p. 104 (key to the included species).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 76.—H. L. Clark, Ann. South African Mus., vol. 13, pt. 7, 1923, p. 233 (questions desirability of recognizing the genus).—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 4.

Liparometra (part) H. L. Clark, Ann. South African Mus., vol. 13, pt. 7, 1923, p. 232.

Diagnosis.—A genus of Mariametridae in which P_3 is the longest and largest pinnule, usually markedly longer than P_2 or P_4, though sometimes not greatly longer (and in young or undeveloped individuals or on undeveloped arms occasionally shorter), and tapers gradually to a delicate tip; the division series are usually in close lateral apposition with more or less flattened sides, less commonly just in contact or even free laterally with the sides slightly or even not at all flattened; the cirri are of moderate length with 22–43 segments, of which the outer are simply carinate dorsally or bear more or less strongly developed dorsal spines or tubercles; and the dorsal surface of the division series is smooth, without ornamentation.

Geographical range.—From southern Japan, from the Korean Straits to Sagami Bay, to Hongkong, the Philippines, the Pelew and Admiralty Islands, New Guinea, and Amboina, and westward to Madagascar and the east coast of Africa from Lamu, Kenya, southward to Durnford Point, Zululand.

Bathymetrical range.—From the shoreline down to 164 meters. The species are epsecially characteristic of the littoral and sublittoral zones, and all but one (*ciliata*) have been taken in shore collecting.

Remarks.—The genus *Dichrometra* as herein considered includes seven species, all of which are rare and none of which are adequately known. These seven species are all very much alike, and the differences between them are slight. Three of the seven species, *flagellata, tenuicirra,* and *afra,* form a group more or less distinct from the others. Although these three are the easiest to recognize, they are probably merely local varieties of the same form. Of the remaining four species, *bimaculata* and *stylifer* seems to have much in common, and *döderleini* and *ciliata* are certainly closely allied.

History.—The genus *Dichrometra* was established by me in 1909 with the genotype *Alecto flagellata* J. Müller, 1841, to include 20 forms that previously had been assigned to the genus *Himerometra.*

In 1913 *Dichrometra,* as originally constituted, was restricted by the removal of 3 forms to the new genus *Liparometra,* 11 to the new genus *Lamprometra,* and 1 to *Oxymetra,* leaving 5 forms of which one (*marginata*) is now placed in *Stephanometra* and another (*subcarinata*) in *Mariametra.* To the three forms remaining (*bimaculata, elongata,* and *flagellata*) were added *döderleini* and *stylifer,* omitted from the original list, and *afra, ciliata, pulcher,* and *tenuicirra,* described after the original list was published.

KEY TO THE SPECIES IN THE GENUS DICHROMETRA

a^1. Cirri slender, with longest earlier segments from two to two and one-half times as long as broad and distal segments about half again as long as broad; 16–26 arms 70–80 mm. long; cirri XIX–XXVIII, 25–28, 20–25 mm. long (Java Sea, from between southeastern Borneo and eastern Java to north of western Java; 0–88 meters)................**tenuicirra** (p. 556)

a^2. Cirri stouter, with longest earlier segments not more than one-third again as long as broad and distal segments broader than long, or at least not appreciably longer than broad.

b^1. About 20 arms 70–115 mm. long; P_3 stout, stiff, and rigid, conspicuously longer and stouter than P_2; cirri 25–35 mm. long, with 30–43 segments, of which the distal are about as long as broad and carinate dorsally without dorsal tubercles or spines (southern Japan from Korean Straits to Sagami Bay; 0–153 meters)------------------------------**stylifer** (p. 538)

b^2. More than 20 (usually 30 or more) arms; P_3 not so conspicuously different from adjacent pinnules; outer cirrus segments usually with dorsal tubercles or more or less developed spines, rarely simply carinate.

c^1. Lower pinnules very unequal, P_2 being nearly or quite twice as long as P_1 and P_3 (largest and longest pinnule on arm) usually much longer than P_2, with 30–36 segments; outer cirrus segments simply carinate dorsally, or with small spines; 36–40 arms 100–215 mm. long; cirri XXX–XL, 25–35, up to 35 mm. long (from Amboina to Philippines; littoral) **bimaculata** (p. 541)

c^2. Lower pinnules much less unequal, P_2 being usually much less than twice as long as P_1, and P_3 not greatly longer than P_2, with usually fewer, or at least not more, segments; distal cirrus segments with dorsal tubercles or spines.

d^1. Lower pinnules rather stout, P_2 and P_3 composed of segments most of which are not longer than broad; synarthrial and articular tubercles more or less developed, giving the proximal portion of the animal a rugged or rugose appearance.

e^1. P_1, P_2, and P_3 not greatly different in length and stoutness; rugosity of division series and arm bases not very marked; 29–50 arms 75–85 mm. long; cirri XX–XLIII, 23–36; P_3 10 mm. long with 22–24 segments (east Africa from Lamu, Kenya, south to Durnford Point, Zululand, and Madagascar; 0–164 meters)---------------**afra** (p. 558)

e^2. P_2 markedly longer than P_1, and P_3 markedly longer than P_2; P_2 and P_3 more or less; enlarged and stout; rugosity of division series and arm bases usually well marked; 14–40 (averaging about 30) arms 65–150 (usually about 110) mm. long; cirri XX–XL, 22–35 (usually 25–30), 15–30 (usually 15–25) mm. long; P_3 9–18 mm. long, with 21–38 (usually 25–30) stout segments (Hongkong to Pelew and Admiralty Islands and New Guinea, and westward to Singapore; 0–45 meters)-------------**flagellata** (p. 544)

d^2. Lower pinnules slender, P_2 and P_3 composed of segments most of which are much longer than broad; division series and arm bases smooth, without synarthrial and articular tubercles.

e^1. More robust, with more numerous (45–47) arms, lower pinnules stiffer and more wiry, with fewer segments; P_1 has 15–24 segments; P_2 has 28–29 segments; and P_3 has 27–29 segments (southern Japan from Sagami Bay to Korean Straits, and southward to Cochinchina; 0–150 meters)------------------------------**döderleini** (p. 562)

e^2. Less robust, with less numerous (34–42) arms, lower pinnules less stiff and wiry, with more numerous segments; P_1 has 29 segments; P_2 has 34 segments; and P_3 has 31 segments (Bay of Bengal from Gopalpore on west to Mergui Archipelago; 44–54 [?69] meters)---**ciliata** (p. 565)

DICHROMETRA STYLIFER (A. H. Clark)

PLATE 59, FIGURE 274; PLATE 61, FIGURE 283

[See also vol. 1, pt. 2, fig. 313 (proximal pinnules), p. 223; pl. 11, fig. 1027 (distal arm fork).]

Antedon stylifer A. H. CLARK, Proc. U. S. Nat. Mus., vol. 33, 1907, p. 127 (color in life), p. 149 (description; *Albatross* Sta. 4929); Unstalked crinoids of the *Siboga* Exped., 1918, p. 104, footnote 1 (synonym of *Dichrometra döderleini*).

Himerometra stylifer A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 266, fig. 2 (Kagoshima Bay; specimen with distal arm division), p. 317 (Japan).

Dichrometra stylifer A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 149 (synonymy; range); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Dichrometra döderleini (part) A. H. CLARK, Unstalked crinoids of the *Siboga* Exped., 1918, p. 104 (in key; range).

Diagnostic features.—P_3 is stout, stiff, and rigid, typically conspicuously longer and stouter than P_2 or P_4, 15–20 mm. long, with 16–25 segments, P_2 being 11–15 mm. long with 17–23 segments; the cirri are XXX, 30–43, 20–35 mm. long, with the segments subequal, all very slightly longer than broad or those in the proximal half slightly longer than broad and those in the distal half slightly broader than long; the distal segments are carinate dorsally, without dorsal tubercles or spines; and the 19–21 arms are 70–115 mm. long.

Description.—The cirri are XXX, 30, 20 mm. long. The segments are remarkably uniform in size, very slightly longer than broad; there are no dorsal processes or opposing spines.

The radials are just visible. The IBr_1 are short, less than half the length of the irregularly rhombic IBr_2 (axillaries), and are in close contact laterally. The IIBr series are 2. The $IIBr_1$ are oblong, about two and one-half times as broad as long, and the IIBr axillaries are triangular, about twice as broad as long. There is a low synarthrial tubercle on the articulations between the elements of the IBr and IIBr series. The IBr series, IIBr series, and first brachials are in close lateral contact.

The 19 arms are 70 mm. long and consist of about 150 brachials, of which the first 8 are oblong, those following as far as the fortieth brachial are triangular, much broader than long, and the remainder are wedge-shaped. The lower brachials are slightly tubercular, and all the brachials have slightly overlapping distal ends.

Syzygies occur between brachials 3+4 and at about brachials 13+14, and distally at intervals of about five muscular articulations.

P_1 8 mm. long, rather slender, and composed of 16 moderately elongated segments. P_2 11 mm. long, stouter than P_1, with 17 segments. P_3 15 mm. long, stout, stiff, and rigid, composed of 16 long cylindrical segments; this pinnule is much stouter and stiffer than any of the others. P_4 10 mm. long. P_5 7 mm. long. The distal pinnules are 8 mm. long, tapering gradually from the base to the tip, with about 20 segments.

Notes.—In one of the specimens from Sagami Bay (No. 4219) the cirri are 25–35 mm. long and composed of 33–43 (usually about 38) segments, which are subequal, about as long as broad, or slightly longer than broad in the proximal half and slightly broader than long in the distal half. The segments in the distal third (or somewhat more) of the cirri are carinate dorsally, but the carination is not produced, so that it is not evident except upon close examination, the outer segments appearing quite smooth. The opposing spine is very small, triangular, with the apex terminal, and arises from the entire dorsal surface of the penultimate segment. The division series and lower brachials are almost in lateral contact, and the lateral edges of the ossicles of the division series are swollen. There are 21 arms about 115 mm. long. All the IIBr series are present, and there is one external IIIBr series.

P_1 is 11.5 mm. long, slender and evenly tapering, composed of 23–25 segments, of which the second and third are about as long as broad and most of the remainder are about twice as long as broad. P_2 is 15 mm. long, with 23 segments, similar to P_1 but stouter and stiffer. P_3 is 20 mm. long, with 25 segments, similar to P_2 but proportionately stouter and stiffer. P_4 is 13.5 mm. long, with 20 segments, and is similar to P_2. P_5 is 10 mm. long, with 19 segments, tapering more rapidly in the proximal third than the preceding pinnules and more slender from that point onward. P_6 and the following pinnules are 9 mm. long, weak, and composed of 17 segments, which are mostly about as long as broad. The pinnules succeeding gradually increase in length and become more slender, the distal pinnules being 11 mm. long, slender, and composed of 23 segments, which become twice as long as broad terminally. P_1 tapers with moderate rapidity in the proximal third, being very slender and delicate from that point onward. P_2 tapers very uniformly and gradually and hence appears stouter than P_1. P_3 tapers even more gradually than P_2 and is the longest and stoutest pinnule on the arm, though it is not especially noticeable as such.

The other specimen from Sagami Bay (No. 9300) is a badly broken example with about 20 arms.

Abnormal specimen.—In an example of this species from Kagoshima Bay, Japan, an arm arising on the inner side of an external IIIBr axillary divides at the sixty-fourth brachial (see Part 2, p. 144, fig. 1027, pl. 11). This axillary ossicle bears a pinnule on the left side. On its distal faces it bears two brachials, that on the right side bearing a pinnule externally, that on the left with none. Each of these brachials is followed by a syzygial pair that, like the ossicles immediately preceding, are interiorly united. The syzygial pair of the left side bears a pinnule on its interior distal angle. The following brachials on each branch of the arm are normal and bear pinnules alternately as usual, except that the pinnule of the second brachial beyond the syzygial pair on the left side is only visible in ventral view, being forced from its normal position by the basal segments of the pinnule of the left syzygial pair, which have grown fast to its lateral border.

In a dorsal view it is seen that the left arm continues the arm anterior to the axillary forward almost in a straight line, while the right branch turns off at a considerable angle. This is especially evident from an examination of the ambulacral groove on the ventral side of the arm.

Remarks.—In 1918 I included *stylifer* in the synonymy of *Dichrometra dőderleini.* It seems, however, to be quite distinct from that species. In *stylifer* P_3 is one-third to one-half again as long as P_2, is composed of 16–25 segments, and is much stouter and stiffer than any of the other proximal pinnules. In *dőderleini* P_3 is little, or even not at all, longer than P_2, is composed of 25–29 much elongated segments, and is not especially stout or stiff.

Localities.—*Albatross* station 4929; in Colnett (or Vincennes) Strait; northeastern point of Yaku Shima bearing N. 16° W., 10 miles distant (lat. 30°12′30″ N., long. 130°43′00″ E.); 153 meters; bottom temperature 23.78° C.; bottom, broken shells, coral, and pebbles; August 15, 1906 [A. H. Clark, 1907, 1908, 1912, 1918] (1, U.S.N.M., 22645).

Kagoshima Bay; U. S. Exploring Expedition [A. H. Clark, 1908] (1, U.S.N.M., 35257).

Sagami Bay, between Ito and Hatsushima; about 150 meters; Doctor Haberer, March 1903 (2, Munich Mus., original Nos. 4219 and 9300).

Geographical range.—Southern Japan from the Korean Straits to Sagami Bay.

Bathymetrical range.—Littoral and down to 153 meters.

Thermal range.—One record, 23.78° C.

History.—Under the name of *Antedon stylifer* this species was first described by me in 1907 from a specimen dredged by the *Albatross* at station 4929.

In my first revision of the old genus *Antedon* published in 1907, *stylifer* was transferred to the new genus *Himerometra*.

On June 16, 1908, I described a case of distal arm division in a specimen of *Himerometra stylifer* collected in Kagoshima Bay, Japan, by the United States Exploring Expedition. In my list of the crinoids of Japan published on July 15, 1908, *Himerometra stylifer* was included.

In my memoir on the crinoids of the Indian Ocean published in 1912, *Dichrometra stylifer* was listed, and the synonymy and range were given. This species had been omitted from the list of forms assigned to the genus *Dichrometra* when that genus was first established in 1909, but it was included in the list of species of *Dichrometra* in my revision of the family Mariametridæ published in 1913.

In my report on the unstalked crinoids of the *Siboga* expedition published in 1918, *Antedon stylifer* was, in a footnote, erroneously placed in the synonymy of *Dichrometra döderleini*.

DICHROMETRA BIMACULATA (P. H. Carpenter)

Antedon bimaculata P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 186 (description; Amboina).—Bell, Proc. Zool. Soc. London, 1882, p. 532 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula); *Challenger* Reports, Zoology, vol. 26, part 60, 1888, p. 226.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 41 (in key).—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1907, p. 131 (color), p. 150 (comparison with *A. delicatissima*); Notes Leyden Mus., vol. 33, 1911, p. 176 (identity); Crinoids of the Indian Ocean, 1912, p. 34 (identity).

Himerometra bimaculata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Dichrometra bimaculata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Notes Leyden Mus., vol. 33, 1911, p. 176 (identity), p. 185 (Amboina; detailed redescription); Crinoids of the Indian Ocean, 1912, p. 34 (identity), p. 151 (synonymy; Amboina); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Unstalked crinoids of the *Siboga* Exped., 1918, p. 104 (in key; range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.

Diagnostic features.—P_3 is much the longest pinnule on the arm, 24–25 mm. long, with 30–36 segments, though it is not especially enlarged and is flexible, particularly distally; P_2 is nearly or quite twice as long as P_1; the 36–40 arms are 100–215 mm. long; the cirri are XXX–XL, 25–35, up to 35 mm. long; the longest proximal cirrus segments are about as long as broad or slightly longer than broad, and the distal are broader than long and are either simply carinate dorsally, or bear small carinate dorsal spines.

Description of the type specimen.—The centrodorsal is a thick spreading disk with a slightly hollowed dorsal surface and marginal cirri.

The cirri are about XL, about 25. The fifth and three following segments are slightly the longest. The following segments diminish slowly in size, and the penultimate has a blunt opposing spine to the terminal claw.

The radials are just visible at the angles of the calyx. The IBr_1 are short and are in close contact laterally. The IBr_2 (axillaries) are more than twice as long as the IBr_1 and are widely pentagonal with open distal angles. The postradial series may divide three times. All the division series are 2. The elements of the division series are slightly raised in the middle of the articulation between them.

There are 36+ arms about 100 mm. long composed of 150 brachials. The first brachials, like the first ossicles following all the axillaries, are rhomboidal and are closely united laterally. The second brachials are shorter than the first and are more wedge-shaped. The first syzygial pair (composed of brachials 3+4) and the five or six following brachials are more oblong. The brachials succeeding are short and sharply wedge-shaped, becoming blunter again at about the fortieth brachial, more oblong, and squarer or slightly elongated toward the arm ends.

The first syzygy is between brachials 3+4, the second is from between brachials 19+20 to between brachials 24+25, and the distal intersyzygial interval is 7–19 (usually 8–12) muscular articulations.

The lower pinnules are stiff. The pinnules of the first pair are small. Those of the next pair (P_2 and P_b) are nearly twice their length, and the following ones (P_3 and P_c) are the longest on the arm, consisting of about 30 stout cylindrical segments. P_4 is nearly as long as P_3, but the pinnules of the next pair (P_5 and P_e) are much smaller, after which the size increases very gradually until near the arm ends; but the outer pinnules, though slender, never become specially long. The pinnules on the fifth and seventh brachials (P_b and P_c) are nearly equal on some of the smaller arms, and the relative sizes of all the lower pinnules are apt to vary a good deal upon arms that have been regenerated from the first or second brachials.

The disk is 17 mm. in diameter, naked and much incised. Sacculi are numerous along the pinnule ambulacra.

The dorsal skeleton is gray up to the last axillary. The arm bases are gray or white and are marked with a double row of purplish spots. The first of these is near the outer end of the line between the second and third brachials, the next toward the inner end of the line separating the first syzygial pair from the following brachial, and so on alternately on opposite sides for four or five brachials. Beyond this limit the arms are dark purple, or almost black, with occasional white patches.

Notes.—The preceding description is based on the original description by Carpenter. He said that the peculiar coloring and the large size of P_3 and P_c readily distinguish this species among the few *Antedons* hitherto recorded from the Moluccas.

I examined the type specimen at Leyden in 1910. This is a very characteristic species and was well described by Carpenter. P_2 is twice as long as P_1. P_3 is considerably longer and stouter than P_2. P_4 is of about the same length as P_2 but has slightly shorter segments. P_5 is considerably shorter, with only 13 segments, but is of the same character as the preceding pinnules. The lower pinnules are stiffened about as is P_2 in *Lamprometra palmata.* They are not especially enlarged and are perfectly smooth, not being basally carinate. P_3 is quite appreciably larger and longer than either P_2 or P_4, there being considerably more difference than in the case of *Dichrometra flagellata.* The centrodorsal is large, thick discoidal, with the dorsal pole concave. The cirrus sockets are arranged in three irregular and crowded rows. There are 40 arms, all of the IIBr and IIIBr series being developed. The division series are laterally flattened. There are faint tubercles on the last 10 or 12 cirrus segments. None of the cirri remain *in situ.*

One of the specimens from Port Galera, Mindoro, has 40 arms 180 mm. long. The cirri are 35 mm. long and are composed of 32–35 segments, of which the outer are carinate dorsally. P_1 is 14 mm. long and is composed of about 30 segments; it is flexible throughout; it tapers rapidly on the first six segments, then becoming slender and flagellate. P_2 is 21 mm. long with 32 segments; it is very slightly larger basally than P_1 but tapers much more gradually, becoming flagellate only in the distal third; it is somewhat stiffened in the proximal two-thirds but flexible in the distal third. P_3 is 24 mm. long with 30+ segments (the tip is broken), which become about as long as broad on the fifth and nearly twice as long as broad in the distal third; it is about as large basally as P_2 but tapers gradually to the tip; it is somewhat stiffened throughout.

Another specimen has also 40 arms.

A third specimen has 39 arms about 130 mm. long. The cirri have 28–30 segments, of which the longest are slightly longer than broad and the distal are nearly twice as broad as long with small but conspicuous dorsal spines that begin at, or more or less beyond, the middle of the cirri. P_3 is the largest and longest pinnule on the arm but is not greatly larger or longer than P_2. P_4 is about like P_2.

A fourth specimen has 37 arms about 215 mm. long. The cirri are XXX, 28–31, moderately stout, uniform in size, with the longest segments about as long as broad and the segments in the distal third with a low carinate dorsal spine. P_1 is 8 mm. long with about 20 segments. P_2 is about twice as long as P_1. P_3 is about 25 mm. long, with 36 segments, and is much the longest and largest pinnule, though it is not especially enlarged and is very flexible.

Localities.—Amboina; coll. Ludeking [P. H. Carpenter, 1881, 1883, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912, 1913, 1918] (1, L. M.).

Port Galera, Mindoro, Philippines; Dr. Lawrence E. Griffin [color described in part 2, p. 717] (7, M. C. Z., 632, 701, 702).

Geographical range.—From Amboina to Mindoro, Philippines.

Bathymetrical range.—Littoral.

History.—Dr. P. H. Carpenter first described this species in 1881 under the name of *Antedon bimaculata* from a specimen in the Leyden Museum that had been collected by Ludeking at Amboina. In the following year Prof. F. J. Bell proposed a specific formula for it, which was emended by Carpenter early in 1883.

In the *Challenger* report on the comatulids published in 1888 Carpenter inserted *bimaculata* in his key to the species of the *Palmata* group, in which it was grouped with *elongata* (=*flagellata*) and *flagellata* under the heading P_3 larger than P_2. Its differential characters were given as "Cirri not spiny; second syzygy about the twentieth brachial," the other two forms being grouped under the heading "Spiny cirri."

Dr. Clemens Hartlaub in 1891 placed *bimaculata* in his key to the species of the *Palmata* group, repeating the differential characters employed by Carpenter.

In my first revision of the old genus *Antedon* published in 1907, *bimaculata* was transferred to the new genus *Himerometra*, and in a revision of the family Himerometridae published in 1909 it was placed in the new genus *Dichrometra*.

In my paper on the comatulids of the Leyden Museum published in 1911, the type specimen of *Antedon bimaculata*, which I had examined in 1910, was redescribed.

Dichrometra bimaculata was listed in my memoir on the crinoids of the Indian Ocean published in 1912 and was included in the key to the species of *Dichrometra* in my report upon the unstalked crinoids of the *Siboga* expedition published in 1918.

DICHROMETRA FLAGELLATA (J. Müller)

Plate 56, Figures 258–262

[See also vol. 1, pt. 2, fig. 719 (disk), p. 346.]

Alecto flagellata J. Müller, Monatsb. preuss. Akad. Wiss., 1841, p. 186 (description; locality unknown); Archiv für Naturg., 1841, vol. 1, p. 145 (same); Abh. preuss. Akad. Wiss., 1841 (1843), p. 216.—A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 176 (identity).

Alecto elongata J. Müller, Monatsb. preuss. Akad. Wiss., 1841, p. 187 (description; New Guinea); Archiv für Naturg., 1841, vol. 1, p. 146 (same); Abh. preuss. Akad. Wiss., 1841 (1843), p. 192.—A. H. Clark, Notes Leyden Mus., vol. 33, 1911, p. 176 (identity).

Comatula elongata J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 257 (redescription).—Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 204 (synonymy; description; New Guinea).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (unable to place in *Antedon* or *Actinometra*).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 30 (identity).

Comatula flagellata J. Müller, Abh. preuss. Akad. Wiss., 1847 (1849), p. 263 (redescription).—Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 206 (synonymy; description; no locality).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (unable to place in *Antedon* or *Actinometra*).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 30 (identity).

Antedon flagellata P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 183 (redescribed).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula).—Bell, Report Zool. Coll. H.M.S. *Alert*, 1884, p. 161 (comparison with *A. gyges*).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 55, 214, 223, 224, 226, 366, 379.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 41 (in key), p. 73 (Singapore; detailed descriptions of the specimens and comparisons; Pelew Islands), p. 113 (in Göttingen Mus.), pl. 4, fig. 45.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 385 (identity); Crinoids of the Indian Ocean, 1912, pp. 34, 37 (identity of previous records).

Antedon elongata P. H. Carpenter, Notes Leyden Mus., vol. 3, 1881, p. 184 (redescribed).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, 1882 (1883), pp. 740 ff. (discussion of Bell's method of formulation and corrected formula); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 35, 54, 224, 226, 366, 379.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 11 (collected by Brock at Amboina), p. 41 (in key), p. 71 (Amboina; detailed description of the specimen; discussion; comparison with the type specimen), p. 113 (in Göttingen Mus.), pl. 4, fig. 47.—Hamann, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, pp. 34, 37 (identity of previous records).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 280 (listed), pp. 410, 411 (synonymy; North China Sea; notes).

Antedon pulcher (Lütken, MS.) Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 73 (Pelew Islands; synonym of *Alecto flagellata; nomen nudum*), pl. 4, fig. 45.—A. H. Clark, Vid. Medd. Naturh. Foren. København, 1909, p. 117 (identity).

Himerometra elongata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Himerometra flagellata A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed).

Dichrometra elongata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); vol. 26, 1913, p. 144 (listed).

Dichrometra flagellata A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed); Vid. Medd. Naturh. Foren. København, 1909, p. 172 (Singapore; descriptions of specimens), p. 193 (collected at Singapore by Svend Gad); Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 13, 28 (in part; African records refer to *D. afra*); Notes Leyden Mus., vol. 33, 1911, p. 176 (includes *elongata*), p. 184 (synonymy; detailed descriptions of the two type specimens); Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, pp. 34, 35 (compared with *D. tenuicirra*); Smithsonian Misc.

Coll., vol. 60, No. 10, 1912, p. 22 (Pelew Islands, previously recorded by Hartlaub), p. 23 (Pitilu; description), p. 24 (compared with var. *afra*); Proc. U. S. Nat. Mus., vol. 43, 1912, p. 385 (identity), p. 398 (Singapore); Crinoids of the Indian Ocean, 1912, pp. 30, 34, 37 (identity of previous records), p. 150 (synonymy; summary of previous records; descriptions of the types of *elongata* and *flagellata*), p. 320 (compared with *D. ciliata*); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed), p. 179 (range in east Asia), p. 181 (8 miles outside Hongkong, 14 fathoms; description); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 30 (Pulau Obin); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (Malayan species; range and its significance).—Hartmeyer, Mitt. zool. Mus. Berlin, vol. 8, Heft 2, 1916, p. 235 (Singapore [Jagor], No. 1282; Singapore [von Martens], No. 1323).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 104 (in key; range), p. 106 (synonymy; notes; stations 43, 144, 213, 250), pp. 271, 273, 274 (listed).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 20, 25; Kungl. Fysiogr. Sällsk. Lund Förh. vol. 7, No. 1, 1936, p. 13.

Dichrometra pulcher A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Diagnostic features.—The longest proximal cirrus segments are about as long as broad or slightly longer than broad, and the distal cirrus segments are broader than long, or at least no longer than broad, and bear well-marked, though usually short, dorsal spines; the division series and arm bases are more or less rugged or rugose, owing to the development of more or less marked, though never exaggerated, synarthrial and articular tubercles; the lower pinnules are markedly unequal in size, but none of them are especially enlarged; P_3 is 9–18 mm. long, with 21–38 (usually 25–30) stout cylindrical segments, and is the longest and stoutest pinnule, markedly longer than P_2, which is 7.5–12 mm. long, with 18–27 (usually about 25) segments; P_1 is small and weak, 4.5–11 (usually 8–9) mm. long, with up to 28 segments; the 14–40 (averaging about 30) arms are 65–150 (averaging about 110) mm. long.

Description.—The centrodorsal is large, or at least moderately large, rarely of medium size, thick discoidal, with more or less sloping and swollen sides or low hemispherical, up to 7 mm. in basal diameter, with the bare dorsal pole usually flat, sometimes more or less deeply concave, about 3 mm. in diameter. The marginal cirrus sockets are arranged in usually two or three, rarely one, irregular and closely crowded rows.

The cirri are XX–XL, 22–35 (usually 25–30), 15 to 30 (usually 15 to 25) mm. long. They are usually rather stout and become laterally compressed distally. They may be practically uniform throughout, or they may be somewhat more slender distally than proximally. The basal segments are short, and those following gradually increase in length to somewhere between the sixth and the tenth, where they become about as long as broad or even up to one-third again as long as broad. The next two to four segments are similar, after which the length gradually decreases so that the distal segments are somewhat broader than long. Often the cirrus segments are all approximately subequal in size. On the eighth–twelfth (usually on the tenth or eleventh) segment a small distally directed dorsal spine appears near the distal end, which increases slightly in size for two or three segments, then remains uniform or diminishes in size, and comes to lie nearer the proximal end of the segment. The dorsal spines usually arise from a long base involving the distal half of the segments. The opposing spine is prominent and is larger than the dorsal spines immediately preceding.

More or less of the anterolateral angles of the radials is visible in the interradial angles of the calyx, though sometimes the radials are almost entirely concealed. The IBr_1 are short, broad, strongly convex dorsally, and almost, or quite, completely united laterally. The IBr_2 (axillaries) are short, less than twice as long as the IBr_1, broadly pentagonal or almost triangular. The IIIBr series are developed entirely, or mainly, externally. IVBr series are occasionally present. The more distal axillaries are relatively longer than the more proximal. The ossicles immediately following each axillary are rhomboidal and are closely united interiorly. The postradial series are either in close lateral contact with flattened sides, or free, or even well separated, laterally. Their outer borders are not thickened. The division series and arm bases are strongly convex dorsally, and slight to moderate synarthrial and articular tubercles are developed, giving the proximal portion of the animal a characteristic rugged or rugose appearance.

The arms are 14–40 (averaging about 30) in number and 65 to 150 (averaging about 110) mm. long. They are usually long and slender, with a smooth dorsal surface, and composed of about 200 rather short brachials. The first brachials are rhombic, or almost rhombic, and are almost, or quite, completely united interiorly. The second brachials are bluntly wedge-shaped, markedly longer exteriorly than interiorly, and of almost the same size as the first, though slightly longer or shorter. The first syzygial pair (composed of brachials 3+4) is oblong, broader than long, or sometimes about as long as broad. The next five or six brachials are short and oblong, after which the brachials become very obliquely wedge-shaped, or even triangular, and somewhat longer, though still relatively short, later becoming bluntly wedge-shaped, after the fortieth–fiftieth brachial shorter and more nearly oblong, and squarish toward the arm tips. The first 3–5 brachials on the two outermost arms of each postradial series have their outer sides flattened.

Syzygies occur between brachials 3+4, again from between brachials 9+10 to between brachials 23+24 (usually from between brachials 15+16 to between brachials 22+23), and distally at intervals of 5–17 (usually 7–14) muscular articulations.

The pinnules of the first pair (P_1 and P_a) are very delicate and slender and are markedly smaller and weaker than the pinnules following. P_1 is 4.5 to 11 (usually 8–9) mm. long and may be composed of as many as 28 segments. It is moderately thick at the base but becomes very slender and delicate in the distal half. P_a is more or less, and often markedly, smaller than P_1. In a specimen from the China Sea in which P_1 is 11 mm. long P_a is 6 mm. long, with 21 segments.

The pinnules of the second pair (P_2 and P_b) are markedly longer than, sometimes twice as long as, those of the first pair (P_1 and P_a) but are always shorter (though sometimes not much shorter) than those of the third pair (P_3 and P_c), which are the longest and stoutest pinnules on the arm. P_2 is 7.5 to 12 mm. long, with 18–27 (usually about 25) segments. It resembles P_3 but tapers more rapidly and abruptly in the proximal portion and is slender from the fifth segment onward. P_3 is usually markedly longer than P_2, and it is also longer than P_4. In its distal portion it becomes very slender and flagellate. It is 9 to 18 mm. long, with 21–38 (usually 25–30) stout cylindrical segments, of which some may be a little longer than broad.

The pinnules of the fourth pair (P_4 and P_d) are almost always shorter than those of the third pair (P_3 and P_c), though they are of variable length and may even be somewhat longer. P_4 is 6 to 12.5 mm. long, with 16–27 segments, much smaller than P_3, intermediate in size between P_2 and P_3, or as large as, or even slightly larger than, P_3. In one specimen on arms arising from a IIIBr axillary P_4 is 12.5 mm. long, with 27 segments, resembling P_3, while on arms arising from a IIBr axillary it is 9 mm. long, with 20 segments. P_5 is much shorter than P_4, and the pinnules following are small and weak, of approximately uniform size. From about the fifteenth or sixteenth pair the length slowly increases so that the distal pinnules are 7–9 mm. long. The enlarged lower pinnules are more or less stiffened and wiry.

The disk is 15–25 mm. in diameter and is incised. Sacculi are numerous to very abundant along the pinnule ambulacra.

Notes.—The specimen from 8 miles outside Hongkong Harbor agrees well with the specimens from Singapore, with which it was compared directly. It has 35 arms 115 mm. long. The IIIBr series are all externally developed. The cirri are XXII, 26–29, from 15 to 20 mm. long.

The two specimens from east of Hongkong are both small, with 28 arms 65 mm. long. In one the cirri are XXVI, 25–27, 15 mm. long.

The specimen from Hongkong has 45 arms about 80 mm. long; the cirri are XXII, 34–39, up to 25 mm. long.

The specimen from the North China Sea was identified by Hartlaub as *Antedon elongata.* He said that in 1891 he had compared a specimen of this relatively rare species (*elongata*) from Amboina directly with the type specimen from New Guinea in the Leyden Museum and had found various differences. It is therefore of interest to see how the specimen from the North China Sea stands in regard to these differences. The centrodorsal, which in the Amboina specimen is rather large, quite flat, and encircled by marginal cirri arranged approximately in a single row, and in the type specimen is "moderately thick convex" and bears two rows of cirri, in the specimen from the China Sea is markedly smaller, discoidal, and encircled by more numerous cirri that are arranged in at least two rows. The cirrus segments, of which in the specimen from Amboina the 10 or 11 outermost bear no dorsal spines, in the Chinese specimen are from the tenth onward armed with small spines, so that the latter agrees better with the type specimen from New Guinea. The position of the second syzygy, which Carpenter gives as usually from between brachials 9+10 to between brachials 18+19, though in the Amboina specimen it is not proximal to brachials 15+16, appears in the Chinese specimen as a rule to occur as in the latter. On one arm Hartlaub found the second syzygy between brachials 9+10; but it was not possible to make an accurate determination of the position of the syzygies because the arms were recurved dorsally. The lower pinnules of the Chinese specimen are very much broken; nevertheless on an outer arm it is seen that P_3 is markedly longer than P_2 and also longer than P_4. P_3 is 11 mm. long and is composed of 28 segments, of which those from the eighth onward are markedly elongated. In its distal portion the pinnule becomes very slender and flagellate. Of quite similar character is P_2, which is 8 mm. long; but it tapers earlier and more abruptly—from the fifth segment onward. Hartlaub was not able to measure P_4 on the same arm. But on another outer arm P_4 was 9 mm. long, with 22 segments. One P_a that Hartlaub was able to measure was 6 mm. long with 21 segments. The pinnules of the first pair are markedly weaker than those following. The uneven and rugose surface of the basal portion of the arms to which Hartlaub in 1891 called attention as especially characteristic of the two specimens known at that time is likewise typically developed in the Chinese specimen. It appears therefore to be one of the best diagnostic characters of the species.

The specimen from the Pelew Islands in the Hamburg Museum, which bears the manuscript name *Antedon pulcher* Lütken, has about 40 arms, which are about 140 mm. long. The centrodorsal is large, low hemispherical, 7 mm. in diameter at the base and 3 mm. in diameter at the concave dorsal pole. The cirrus sockets are arranged in three closely crowded irregular marginal rows. The cirri are about XL, 27–29, 25 mm. long. The longer proximal segments are about as long as broad. Rather low and blunt dorsal spines are developed from the tenth or twelfth segment onward. The cirri are, as usual, rather stout. The division series and arm bases are strongly convex and rugged. P_3 is the longest pinnule, about 15 mm. in length, and is composed of about 20 segments.

The specimen from the Admiralty Islands has 28 arms 150 mm. long. The longest cirri have 32 or 33 segments; dorsal spines are developed from the eleventh or twelfth segment onward. P_3 is 15 mm. long, with 28 or 29 segments. This specimen is intermediate in character between the two in the Leyden Museum upon which Müller based the names *flagellata* and *elongata*, though rather nearer the latter.

Müller described *Alecto elongata* from New Guinea as follows: There are 20 arms 100 mm. long. The cirri are XV–XX, 23–25. The last 15–17 cirrus segments bear dorsally a spurlike sharp process, and the outermost bears the terminal claw. The axillaries are without a syzygy. Between two axillaries there is always only one segment. Beyond the last axillary the third segment has a syzygy, and beyond that there are 5–11 brachials between the syzygies (that is, the first syzygy is between brachials 3+4, and the distal intersyzygial interval is 6–12 muscular articulations). The pinnules at first increase in length so that the third is the longest. Then they gradually decrease again. Their segments are rounded and smooth. The color is dark.

Carpenter redescribed Müller's type specimen under the name of *Antedon elongata* as follows: The centrodorsal is a moderately thick convex disk bearing the cirri in two irregular rows around its margin. The cirri are about XXX, 25–30. The segments are of tolerably even size, the sixth and four following ones being slightly longer than broad. The succeeding ones bear slight dorsal spines, that on the penultimate enlarging somewhat as an opposing spine to the terminal claw. The radials are just visible. The IBr_1 are laterally united and are short, broad, and very convex. The IBr_2 (axillaries) are short, less than twice the length of the IBr_1, and pentagonal, with wide distal angles. The postradial series may divide three times. All the division series are 2. The first ossicles immediately following each axillary are rhomboidal, closely united laterally, and form with their successors a slight tubercular elevation in the middle of their line of junction. The postradial series are well separated. The arms are 20+ in number, about 125 mm. long, and consist of over 200 brachials. The second brachials are bluntly wedge-shaped and slightly longer than the first brachials. The first syzygial pair (composed of brachials 3+4) and the fifth brachial are short and oblong. The next few brachials have slightly oblique terminal faces, and those following are smooth, short, and sharply wedge-shaped, becoming shorter and blunter about the fortieth brachial and squarer toward the ends of the long arms. The first syzygy is between brachials 3+4, and the second is usually from between brachials 9+10 to between brachials 18+19. The distal intersyzygial interval is 5–12, usually 7–9, muscular articulations. The first two pinnules are moderately short and slender, the size increasing up to those borne on the sixth, seventh, and eighth brachials (P_3,

P_c, and P_4). These have wide basal segments, the later ones being longer and tapering rather rapidly. The pinnules on the ninth and tenth brachials (P_d and P_5) are a good deal smaller than that on the eighth (P_4), but larger than the pinnules of the first pair (P_1 and P_a). The following pinnules gradually increase in length and slenderness, their component segments becoming more and more cylindrical, but they never exceed in length those of the third pair (P_3 and P_c). The terminal pinnules are again shorter, and are very thin and delicate. The disk is lost. The diameter across the circle of IIIBr axillaries is about 14 mm. Sacculi are numerous at the sides of the pinnule ambulacra. The color in alcohol is brownish white, with the perisome darker.

I examined this specimen at Leyden in 1910. The cirri are XXIV, 25. The longest cirrus segments are about one-third again as long as broad. The ninth or tenth and following segments bear small but prominent dorsal spines. There are about 20 very long and slender arms. Six IIBr series and four IIIBr series, the latter developed externally, are present. The synarthrial tubercles are slightly prominent, and the basal portion of the arms is rugose as in *Lamprometra palmata.* The division series are not in lateral contact, though they have tolerably straight sides. The IBr_1 are entirely united laterally, but the axillaries are free. There are no lateral processes such as are seen in *Stephanometra.* P_3 has 20–22 segments. P_1 is small and weak. P_2 is nearly twice as long as P_1, and P_3 is still longer. P_4 is nearly as large as P_3, being intermediate in size between P_2 and P_3. P_5 is much shorter. The pinnules following are small and weak. The proximal pinnules resemble those of the type specimen of *Alecto flagellata,* but are slightly less stiffened and are more flexible and more flagellate distally.

Between this specimen and the type specimen of *Alecto flagellata* there appear to be no differences not to be accounted for by the difference in the size of the two individuals, and there can be no doubt that in reality they represent the same species.

The specimen collected by Dr. Brock at Amboina was thus described by Hartlaub: The centrodorsal is a disk of medium size with a flat dorsal pole and entirely marginal cirri. The cirri are fully XX, 22–27, about 15 mm. long. They are moderately broad basally but more slender and more compressed distally. The sixth and the three following segments are a little longer than broad. The 10 or 11 outermost segments bear small dorsal spines. The opposing spine is rather stout. The radials are visible in the interradial angles of the calyx. The IBr_1 are short and broad and are laterally united. The IBr_2 (axillaries) are short, broadly pentagonal or almost triangular. The postradial series are not separated but are in lateral contact through their outer edges. They divide not more than three times, and the IIIBr series, when present, occur only on the outer side of the IIBr axillaries. All the division series are 2; the axillaries are longer distally than proximally. The articulation between the elements of the division series is faintly tubercular.

There are about 25 moderately long slender arms 100 mm. in length, with a smooth dorsal surface and composed of moderately short brachials. The first brachials are rhombic and are almost completely united interiorly. The second brachials are almost equally large but are markedly longer outwardly than inwardly. The first syzygial pair (composed of brachials 3+4) is broader than long, and is followed by five or six discoidal brachials. The surface of this portion of the arms is uneven in that the articulation between the brachials is depressed on one side and raised on the other. On each side of the arm protuberances and depressions alternate so that the surface here has a wrinkled or pleated appearance which is very characteristic of the species. The brachials following are triangular, farther out becoming bluntly wedge-shaped and then again moderately discoidal. The outermost brachials are approximately square. Syzygies occur between brachials 3+4, again from between brachials 15+16 to between brachials 22+23, and distally at intervals of 7–9 muscular articulations.

P_1 is about 9 mm. long. It is moderately thick at the base but becomes very slender and delicate in the distal half. P_a is markedly smaller. The pinnules of the two following pairs are about 12 mm. long. The difference in size between the pinnules of these two pairs is very slight, but P_3 and P_c are a little longer than P_2 and P_b. They are composed of about 25 segments of which some may be a little longer than broad. The length of the pinnules of the three following pairs decreases. The distal pinnules are 7 mm. long. The disk is 15 mm. in diameter and is incised. Sacculi are very abundant on the pinnules. The dorsal skeleton and the disk are uniform dark gray-brown; the centrodorsal, the cirri, and the ends of the arms are lighter chocolate-brown.

Hartlaub said that this specimen differs from the type specimen of *elongata* from New Guinea at Leyden in various features, and before he had compared them directly the specific identity of the two seemed to him doubtful.

The centrodorsal of the specimen from Amboina (in the Göttingen Museum) is quite flat, and there are XX–XXV cirri, while the centrodorsal of the type specimen is "moderately thick convex," and there are XXX cirri. The postradial series of the type specimen are "well separated," while those of the specimen from Amboina are in lateral contact. Carpenter gave the position of the second syzygy in the type specimen as usually from between brachials 9+10 to between brachials 18+19, while Hartlaub found in the specimen from Amboina that it was not earlier than between brachials 15+16. Carpenter said that in the type specimen P_d and P_5 are "a good deal smaller than that on the right, but larger than the first pair," while Hartlaub found them always smaller than P_1 and in no case larger than P_a, which sometimes is weaker than P_1. Finally, the distal pinnules of the type specimen are markedly longer than those in the specimen from Amboina. Carpenter said that "they never exceed the length of the third pair," or in other words, that their length occasionally reaches that of the third pair. Hartlaub said that in the specimen from Amboina this is never the case.

Hartlaub said it seemed to him that the differences mentioned between the specimen from Amboina and the type specimen of *elongata* are not of sufficient importance to justify a separation into two species, especially since the general habitus of the two individuals is quite the same, and more particularly since the uneven and pleated surface of the basal portion of the arms is a characteristic feature of the species. He said that this species (*elongata*) is in every respect very near *flagellata* but differs from it in the character just mentioned and also in the very different form of the centrodorsal; also the number of arms is much smaller than in *flagellata*.

The specimen from *Siboga* station 250 has 20 arms 115 mm. long, all the IIBr series being present. The cirri are XXIV, 24–25, 18 mm. long; dorsal spines are developed from the tenth or eleventh segments onward. P_1 is 4.5 to 6.0 mm. long.

P_2 is 7.5 to 9.5 mm. long and composed of 25 segments. P_3 is 9.0 to 11.5 mm. long, with 21 segments. P_4 is 6.0 to 6.5 mm. long, with 16 segments. The color is whitish with broad, frequent, and regular bands of purple on the arms, which become more closely crowded distally so that the outer portion of the arms is purple with narrow white bands.

The specimen from *Siboga* station 213 (Saleyer) is large, with 40 arms about 100 mm. long. The cirri are XXII, 29–30, 27 mm. long. It agrees very well with the type specimen in the Leyden Museum.

The specimen from *Siboga* station 144 has 18 arms 90 mm. long. The longest cirri are 16 mm. long and are composed of 22–24 segments, of which the ninth or tenth and following bear dorsal spines.

The specimen from *Siboga* station 43 has the cirri XXI, 27–28, from 20 to 21 mm. long. The longest segments are about one-third again as long as broad. The short distal segments are only slightly broader than long. Dorsal spines, which are somewhat smaller than in specimens at hand from Singapore, are developed from the eighth or ninth segment onward. The 14 arms are 115 mm. long. Only one IIIBr series is present, developed externally. P_1 is 8 mm. long, with 28 segments. P_2 is 11.5 mm. long, with 27 segments. P_3 is 15 to 17.5 mm. long, with 30–38 segments. P_4 is 9 mm. long, with 20 segments on arms arising from a IIBr axillary, and 12.5 mm. long with 27 segments on arms arising from a IIIBr axillary. In the latter case it resembles P_3. The color is deep purple.

Dr. Clemens Hartlaub redescribed *Antedon flagellata* on the basis of three specimens from Singapore, two collected by Jagor in the Berlin Museum and one collected by von Martens in the Göttingen Museum. The centrodorsal is large and thick with swollen sides and a deeply concave bare dorsal pole. The cirri are arranged in two or three irregular rows. The cirri are about XXX–XXXV, 25–30, the longest 25 mm. long. The sixth and four following segments are slightly longer than broad; those succeeding are shorter, practically all of them of equal size, and bear small distally directed spines that usually arise from a long base involving the distal half of the segment. The radials are visible in the interradial angles of the calyx. The IBr_1 are broad and short, and are more or less completely united with their neighbors. The IBr_2 (axillaries) are short, and are broadly pentagonal or almost triangular. The postradial series are free laterally or in lateral contact. They divide three times, so that as a rule each postradial series bears eight arms. All the division series are 2. Moderately strong synarthrial tubercles are present. There is no thickening of the outer sides of the postradial series. There are 40, or almost 40, arms about 90 mm. long with a smooth dorsal surface and composed of short brachials. The first brachials are rhombic, or almost rhombic, and are entirely united interiorly. The second brachials are shorter than the first, and are a little longer exteriorly than interiorly. The first syzygial pair (composed of brachials 3+4) is squarish. The next five or six brachials are short and discoidal, those succeeding triangular, later bluntly wedge-shaped, and finally more squarish. The four or five lowest brachials have as a rule somewhat flattened outer sides. The first syzygy is between brachials 3+4, the second is from between brachials 17+18 to between brachials 23+24, and the distal intersyzygial interval is usually 12–14 muscular articulations.

P_1 and P_a are very delicate and slender and measure about 11 mm. in length. The pinnules of the next pair (P_2 and P_b) are markedly longer, though always shorter than those of the third pair (P_3 and P_c), which are the longest and stoutest. P_3 reaches 18 mm. in length and is composed of 25–30 segments, which except for the basal are longer than broad. The pinnules of the fourth pair (P_4 and P_d) are almost always shorter, though they are of variable length and may even be longer than those preceding. Following these there is a series of small pinnules of moderately equal size, an increase in length being first observable from the fifteenth or sixteenth pair onward. The distal pinnules are about 9 mm. long. The disk is not present but was apparently about 14 mm. in diameter. The color is light brown or light chocolate-brown, with the central portion sometimes entirely light brownish white.

Hartlaub said that the single specimen of this species (*flagellata*) previously known, which is in the Leyden Museum, was first described by J. Müller and later by Carpenter. Its locality was unknown, but Carpenter correctly surmised that it was "oriental." The specimens from Singapore that he studied are smaller than the type specimen at Leyden, though in other respects wholly similar. Hartlaub believed the form of the centrodorsal to be very characteristic. It is large and thick, and Carpenter's designation "moderately thick" seemed to him not quite adequate for the type specimen at Leyden, which he personally examined, or for those from Singapore. In contrast to the type specimen, the centrodorsals of the specimens from Singapore have strongly concave dorsal poles, while the number of cirrus segments in the latter is not 40, as in the type specimen, but scarcely more than 30–35. IVBr series, which occur in the type specimen, are not present in any of the specimens from Singapore.

Of the specimens collected at Singapore by Svend Gad four have the arms 90 mm. long and the cirri XL, 20 mm. long; they resemble very closely those described by Hartlaub. Another is small.

The specimen from Singapore collected by Dr. Th. Mortensen has 42 arms about 130 mm. long. The cirri have 25–29 segments and are 24–30 mm. long. P_2 is 10 mm. long, with 18 segments. P_3 is 18 mm. long, with 25+ segments. The disk is 25 mm. in diameter.

The type specimen of *Alecto flagellata*, which was without locality, was thus described by Müller: There are 38 arms 150 mm. long. The cirri are XXXV, 30, long and stout with low, flat segments of which the last, except for the claw, bears dorsally a clawlike process. The axillaries are very low, without a syzygy. Between the syzygies of the arms there are 10 or 11 brachials, which are wedge-shaped, directed alternately to the right and left. From the first to the third on the same side of the arm the pinnules increase in length; these three first pinnules are very long, those succeeding gradually decreasing in length.

Carpenter redescribed the type specimen of Müller's *Alecto flagellata* as follows: The centrodorsal is moderately thick, with a smooth dorsal surface and three irregular rows of cirri on its sides. The cirri are about XL, 25–35. The segments are tolerably equal, hardly any of them in mature cirri being longer than broad. The lowest segments are short, the length increasing gradually up to the tenth, which is about square. The next two or three segments are of the same shape or a trifle longer, after which the length gradually decreases and a blunt dorsal spine appears near the distal ends of the segments. It increases slightly in size for two or three segments, then diminishes and comes to be nearer their proximal ends, reappearing on the penultimate segment as a moderately strong opposing spine. The radials are scarcely visible even at the angles of the calyx. The IBr_1 and IBr_2 are very convex, the former in close contact laterally, the latter less than twice their length, almost triangular with very open angles. The postradial series may divide four times. All the division series are 2. The axillaries are short and broad with an open angle. The ossicles immediately following each axillary are closely united laterally, and are slightly raised in the middle of their junction with their successors.

The 38 arms are about 125 mm. long and are composed of about 200 brachials. The first three or four brachials on the two outer arms of each postradial series have their outer sides flattened where they are apposed to their fellows of the next postradial series. The first brachials are rhomboidal. The second are shorter and more wedge-shaped. The first syzygial pair (composed of brachials 3+4) is more nearly oblong. The next five or six brachials are short and oblong, after which the brachials become sharply wedge-shaped and somewhat longer, though still relatively short. After about the fiftieth the brachials become blunter and more oblong, and finally somewhat square toward the arm ends. The first syzygy is between brachials 3+4 and the next usually from between brachials 16+17 to between brachials 22+23. The distal intersyzygial interval is 10–17 muscular articulations.

The largest pinnules are those borne on the fourth and five following brachials. P_3 and P_c are the longest pinnules on the arm and consist of 25–30 stout cylindrical segments. The pinnules of the first pair (P_1 and P_a) are considerably shorter and smaller than their three successors on each side. The pinnule on the tenth brachial (P_5) is small on the inner arms of a postradial series, but more equal to its predecessor on the outer arms. The next few brachials bear the smallest pinnules on the arm, after which the length of the pinnules gradually increases toward the arm ends, but the pinnules never become specially long. The disk is 25 mm. in diameter and is naked and much incised. Sacculi are not very abundant along the pinnule ambulacra. The color in alcohol is brownish white, with grayer perisome.

In 1910 I examined this specimen at the Leyden Museum. The centrodorsal is rather large, with the dorsal pole concave. The cirri are XL, 24, 25, 28, and 30. The dorsal spines are very small and tubercular. There are 39 arms. The IIIBr series are developed externally. The division series and first six or eight brachials are in close lateral apposition and are sharply flattened laterally. P_1 is very small and short. P_2 is large, over twice as long as P_1, and is of the same character as the corresponding pinnule in *Lamprometra palmata;* its segments are slightly longer than broad. P_3 is slightly longer and larger than P_2. P_4 is of about the same size as P_2. P_5 is somewhat smaller than P_4. The pinnules following are small and weak. The enlarged lower pinnules are strongly curved outward and backward; they stand out very prominently through their large size, the middle and outer pinnules being especially short.

Localities.—Eight miles outside Hongkong Harbor (lat. 22°12′ N., long. 114°15′ E.); 25 meters; Captain Suensson, November 16, 1911 [A. H. Clark, 1913] (1, C. M.).

East of Hongkong (lat. 23°15′ N., long. 117°40′ E.); Captain Christiansen, July 26, 1912 (2, C.M.).

Hongkong (1, C.M.).

North China Sea; North Pacific Exploring Expedition [Hartlaub, 1912].

Pelew Islands [Hartlaub, 1891 (Palau-Inseln); A. H. Clark, 1912] (1, H.M.).

Pitilu, Admiralty Islands (north of eastern New Guinea); Dr. G. Duncker [A. H. Clark, 1912] (1, H.M.).

New Guinea; Salomon Müller [J. Müller, 1841, 1843, 1849; Dujardin and Hupé, 1862; P. H. Carpenter, 1879, 1881, 1883, 1888; Bell, 1882; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912] (1, L. M.).

Amboina; Dr. J. Brock [Hartlaub, 1891].

Siboga station 250; anchorage off Kilsuin, western coast of Kur Island; 27 meters; bottom, coral and lithothamnion; December 6–7, 1899 [A. H. Clark, 1918] (1, U.S.N.M., E. 422).

Siboga station 213; Saleyer (south of western Celebes); down to 36 meters; coral reefs, mud, and mud with sand; October 26, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 144; anchorage north of Salomakieë (Damar) Island; 45 meters; bottom, coral and lithothamnion; August 7–9, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Siboga station 43; anchorage off Pulu Sarassa, Postillon Islands; down to 36 meters; coral bottom; April 4–5, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Singapore; Herr Jagor [Hartlaub, 1891; A. H. Clark, 1912 (given by error as Prof. J. Müller); Hartmeyer, 1916] (1, Berl. M., 1282).

Singapore; Prof. Edouard von Martens [Hartlaub, 1891]. Same [Hartmeyer, 1916] (1, Berl. M., 1323).

Singapore; Svend Gad [A. H. Clark, 1909, 1912] (6, U.S.N.M., 35238; C.M.).

Singapore; Dr. Th. Mortensen, June 1, 1900 (1).

Pulau Obin, Singapore [A. H. Clark, 1913] (5, B. M.).

No locality; Herr Brugmans [J. Müller, 1841, 1843, 1849; Dujardin and Hupé, 1862; P. H. Carpenter, 1879, 1881, 1883, 1888; Bell, 1882, 1884; Hartlaub, 1891; A. H. Clark, 1907, 1909, 1911, 1912] (1, L. M.).

Geographical range.—From Hongkong to the Pelew Islands, the Admiralty Islands, and New Guinea (Papua), and westward to Singapore.

Bathymetrical range.—Littoral; from the shoreline down to 45 meters.

History.—Prof. Johannes Müller in 1841 described *Alecto flagellata* from a specimen without locality collected by Brugmans in the Leyden Museum that he found bearing the manuscript name *Comatula flagellata*. At the same time he described *Alecto elongata* from another specimen in the same museum that had been collected in New Guinea by Salomon Müller and bore the manuscript name *Comatula elongata*. He mentioned *Alecto flagellata* and *A. elongata* in 1843, and in 1849 he redescribed them under the names *Comatula flagellata* and *C. elongata*.

Dujardin and Hupé in 1862 published translations of Müller's original descriptions of *Comatula elongata* and *C. flagellata*.

Dr. P. H. Carpenter in 1879 was unable to refer either *Comatula elongata* or *C. flagellata* definitely to *Actinometra* or to *Antedon*, as he had not seen them and knew of no descriptions from which it is possible to obtain any information as to the position of the mouth or the character of the oral pinnules.

Carpenter in 1881 published a redescription of Müller's type specimen under the name *Antedon flagellata.* He said that the general facies of this fine species leaves little room for doubting its oriental origin, but he had never come across a second specimen of it. He said that the specific name, as in the case of Müller's other types in the Leyden Museum (except *Actinometra solaris*), seems to have been a museum name which was adopted by him.

Carpenter remarked that two *Myzostoma* cysts occur on the arms of the type specimen that seem to have escaped Müller's attention.

Prof. F. Jeffrey Bell in 1882 proposed specific formulas for *Antedon elongata* and *A. flagellata,* which were criticized and emended by Carpenter early in the following year. In the *Alert* report published in 1884 Professor Bell compared *Antedon flagellata* with his new species *Antedon* (= *Lamprometra*) *gyges.* He also published a redescription of the type specimen of Müller's *Alecto elongata* under the name of *Antedon elongata.*

In the *Challenger* report on the comatulids published in 1888 Carpenter inserted *elongata* and *flagellata* in his key to the species of the *Palmata* group of *Antedon; elongata* was said to have the postradial series well separated, no IVBr series, and the second syzygy about the fourteenth brachial, while in *flagellata* the postradial series are in close contact and slightly flattened laterally, IVBr series are present, and the second syzygy is about the twentieth brachial. These two species were differentiated from *bimaculata* by having spiny cirri, and all three were differentiated from the remaining species of the *Palmata* group by having P_3 larger than P_2.

Dr. Clemens Hartlaub in 1891 redescribed *Antedon elongata* from a specimen from Amboina that had been collected by Dr. J. Brock. He compared this specimen directly with the type specimen at Leyden and gave in detail the differences between them. He said that *elongata* seemed to be a rare form, as the single example previously known was the type, and he had not seen another among the comatulids either in Berlin or in Hamburg. He also redescribed *Antedon flagellata* in detail on the basis of three specimens from Singapore, two in the Berlin Museum collected by Jagor and one in the Göttingen Museum collected by Prof. Edouard von Martens. He compared these with the type specimen at Leyden and recorded another specimen from the Pelew Islands that he had found in the Hamburg Museum bearing the manuscript name *Antedon pulcher* Lütken. He included *elongata* and *flagellata* in his key to the species of the *Palmata* group, using the differential characters employed by Carpenter.

In my first revision of the old genus *Antedon* published in 1907, *elongata* and *flagellata* were placed in the new genus *Himerometra,* and in my revision of the family Himerometridae published in 1909 they were both transferred to the new genus *Dichrometra.*

In a paper on the crinoids of the Copenhagen Museum published in 1909, I recorded and gave notes on five specimens of *Dichrometra flagellata* from Singapore that had been collected by Svend Gad, the Danish consul at that port.

In a paper on the crinoids of the coasts of Africa published in 1911, I listed *Dichrometra flagellata* from Lamu and Zanzibar, taking the records from Ludwig, 1899, and said that the species ranges eastward to Singapore, New Guinea, and Amboina. New Guinea and Amboina are included on the basis of the type specimen of *Alecto elongata* from New Guinea and the specimen of *Antedon elongata* from Amboina described by Hartlaub, although no mention is made of the inclusion of *elongata* in the synonymy of *flagellata*. The east African specimens are herein regarded as representing *D. afra* (see page 558).

I examined the type specimens of *Alecto flagellata* and *A. elongata* at the Leyden Museum in 1910, and in a paper on the crinoids of that museum published in 1911 I placed *Alecto elongata* in the synonymy of *Dichrometra flagellata* and gave extended notes on both specimens.

In a paper on the crinoids of the Berlin Museum published in 1912, I recorded a specimen of *Dichrometra flagellata* from Singapore collected by Prof. J. Müller. Professor Müller never visited Singapore; the specimen in reality was one of those collected by Jagor and described by Hartlaub in 1891.

In a paper on the crinoids of the Hamburg Museum published in 1912, I described the specimen from the Pelew Islands previously recorded by Hartlaub, and another that had been collected by Dr. G. Duncker at Pitilu in the Admiralty Islands.

In my memoir on the crinoids of the Indian Ocean published in 1912, I placed *Alecto elongata* in the synonymy of *Dichrometra flagellata* and gave extended notes on the type specimens of both *flagellata* and *elongata*. I also compared *flagellata* with the new species *Dichrometra ciliata*. In my description of *Dichrometra tenuicirra* published in 1912, I compared this new form with *D. flagellata*.

Hartlaub in 1912 described in detail and figured a specimen of *Antedon elongata* from the North China Sea that had been collected by the United States North Pacific Exploring Expedition. This specimen had been sent to Carpenter with the *Blake* collection, and after Carpenter's death it had been sent to Hartlaub with that collection.

In a paper on the crinoids of the British Museum published in 1913, I recorded five specimens of *Dichrometra flagellata* from Pulau Obin, Singapore Island, and in a paper on a collection of crinoids made by Captain Suensson in eastern Asia published in the same year I recorded and gave notes on a specimen from Hongkong.

Dr. Robert Hartmeyer in a paper published in 1916 corrected my record of a specimen in the Berlin Museum from Singapore, and recorded another from the same locality that had been collected by Prof. Edouard von Martens.

In my memoir on the comatulids collected by the *Siboga* expedition I recorded and gave notes on specimens of *Dichrometra flagellata* collected at stations 43, 144, 213, and 250.

DICHROMETRA TENUICIRRA A. H. Clark

Plate 59, Figure 275

[See also vol. 1, pt. 1, fig. 342 (cirrus), p. 287.]

Dichrometra tenuicirra A. H. Clark, Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 34 (description; *Siboga* station 320); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga* and its significance), p. 104 (in key; range), p. 105 (references; detailed description; stations 318, 320), fig 5, p. 105 (cirrus), p. 276 (listed), pl. 19, fig. 39; Treubia, vol. 14, livr. 2, 1933, p. 207 (previous record), p. 213 (north of central Java; Java Sea; notes).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 20.

Diagnostic features.—The cirri are slender, XIX–XXVIII, 25–28, 20–25 mm. long, with the longest proximal segments two to two and one-half times as long as broad and the shorter distal segments about half again as long as broad; the 16–26 arms are 70–80 mm. long; P_1 is 6–6.5 mm. long, with 15–18 segments; P_2 is 7 mm. long, with 22 segments; P_3 is 9 mm. long, with 23 segments; P_4 is 8 mm. long, with 20 segments. Except for the slender, long-jointed cirri this species does not differ in any essential feature from *D. flagellata.*

Description.—The centrodorsal is low hemispherical with very sloping sides, the dorsal pole slightly convex, flat or very slightly concave, 1.5 to 2.5 mm. in diameter. The cirrus sockets are arranged in two, or in two and a partial third, irregular and crowded marginal rows.

The cirri are XIX–XXVIII, 25–28 (usually 26), 20 to 25 mm. long, slender and delicate; the tenth–twelfth (usually the twelfth) is a more or less marked transition segment. The first segment is very short, the second is twice as broad as long, the third is slightly broader than long, the fourth is half again to twice as long as the median width, and the fifth is two to two and one-half times as long as broad. The following to the ninth, tenth, or eleventh are similar, the remainder slightly shorter, about half again as long as broad. The tenth–twelfth and following segments have prominent triangular median spines; after one or two segments these spines occupy about half of the middorsal line, the anterior (distal) margin standing out vertically and one-half to one-third as long as the recumbent side, the hypothenuse, from the apex of the spine to the proximal base, straight, its proximal end sometimes marked by a slight tubercle, or slightly concave, running from the distal spine to a smaller blunt proximal tubercle. The spines change but little distally, their bases becoming slightly shorter and their apices consequently sharper, and the hypothenuse straight. The opposing spine is longer than the spines on the preceding segments and more slender, median or submedian, nearly or quite erect, nearly or quite equal to the width of the penultimate segment in height. The terminal claw is longer than the penultimate segment, very long and slender, slightly and evenly curved. The longer earlier segments have slightly enlarged ends, this feature becoming less marked in the spiniferous distal segments, though traceable quite to the penultimate.

The division series and arms resemble those of *D. flagellata,* but are much more slender and delicate. The division series and first brachials may be well separated, or they may be in lateral contact; they are usually not quite in apposition, though they have straight lateral edges which are usually slightly swollen. The characteristic rugose appearance of *D. flagellata,* due to the low, though prominent, synarthrial and articular tubercles, is reflected in a delicate and modified form.

The arms are from 16 to 23, from 70 to 80 mm. long.

P_1 is 6.0 to 6.5 mm. long, with 15 to 18 segments, of which the first is short, the second nearly as long as broad, and the seventh or eighth and following slightly longer than broad. P_2 is 7 mm. long, with 22 segments, of which the first is short, the second about as long as broad, the third slightly longer than broad, and the seventh or eighth and following half again as long as broad, becoming twice as long as broad terminally. The pinnule is very slightly stouter basally than P_1, but tapers less rapidly and more gradually, and is less flagellate distally. P_3 is 9 mm. long, with 23 segments, resembling P_2 but proportionately stouter. P_4 is 8 mm. long with 20 segments, resembling P_3; the second–fourth segments are sometimes very slightly enlarged. P_5 is 4.5 mm. long, with 14 segments, of the same character as P_4 but proportionately smaller. P_6 is

4.2 mm. long, with 13 segments, similar to P_5. P_7 is 3.7 mm. long, with 12 segments, similar to P_6. The following pinnules are of about the same length and stoutness, becoming weaker and more delicate distally. The distal pinnules are 6 mm. long, very slender, with 18 or 19 segments.

Notes.—The preceding description is based upon specimens from *Siboga* station 320, the type locality.

The largest of the five specimens from north of central Java has 26 arms.

Remarks.—In nearly every detail of its structure this species agrees with *D. flagellata.* With the type specimen of Müller's *Alecto elongata* the agreement is especially close, in the number of cirri, the number of cirrus segments, the number of the cirrus segment that bears the first dorsal spine, the proportions of the lower pinnules, and the number of the component segments of the proximal pinnules. But the slenderness of the cirri, which have much elongated distal segments, serves easily to distinguish it.

Localities.—*Siboga* station 318; between Borneo and eastern Java (lat. 6°36′30″ S., long. 114°55′30″ E.); 88 meters; fine yellowish gray mud; February 22, 1900 [A. H. Clark, 1918] (1, U.S.N.M., E. 408).

Siboga station 320; between Borneo and eastern Java (lat. 6°05′00″ S., long. 114°07′00″ E.); 82 meters; February 23, 1900 [A. H. Clark, 1912, 1918] (25, U.S.N.M., E. 465; Amsterdam Mus.).

Java Sea, north of central Java (lat. 5°41′ S., long. 109°21′ E.); November 21, 1907 [A. H. Clark, 1933] (5).

Java Sea, northnortheast of Indromayu Point, Java (lat. 4°55′ S., long. 108°56′ E.); October 23, 1907 [A. H. Clark, 1933] (2).

Geographical range.—Java Sea, from between southeastern Borneo and eastern Java to north of western Java.

Bathymetrical range.—From the shoreline down to 88 meters.

History.—I originally described this species in 1912 from specimens dredged by the *Siboga* at station 320. In my report on the unstalked crinoids of the *Siboga* Expedition published in 1918 I recorded it also from station 318.

Additional specimens from two localities were found in the collection of the Zoological Museum at Buitenzorg, Java, which were recorded by me in 1933.

DICHROMETRA AFRA A. H. Clark

PLATE 58, FIGURES 269, 270

Antedon flagellata LUDWIG, Abh. Senck. naturf. Ges., vol. 21, Heft 4, 1899, p. 538 (reef before the harbor of Lamu; Zanzibar; 3 specimens from each locality).—A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 4 (recorded by Ludwig from Zanzibar).

Dichrometra sp. A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 27 (Cape St. André, Madagascar, about 30 m.; Zanzibar; description; relationships); Bull. Mus. Hist. Nat., Paris, 1911, p. 254 (Cape St. André, Madagascar, about 30 m.; description; affinities); Crinoids of the Indian Ocean, 1912, p. 152 (same); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936 (Jan. 1, 1937), p. 100 (identity).

Dichrometra flagellata var. *afra* A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 23 (Madagascar; description; includes *A. flagellata* Ludwig, 1899, and *Dichrometra*, spp. A. H. Clark), p. 24 (comparison with *D. flagellata*); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 100 (range).—GISLÉN, Kungl. Svenska Vet. Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 4.

Dichrometra afra A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 31 (Zanzibar); Unstalked crinoids of the *Siboga* Exped., 1918, p. 105 (in key; range); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 641 (Zanzibar).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25; John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 104.

Liparometra multicirra H. L. Clark, Ann. South African Mus., vol. 13, pt. 7, 1923, p. 232 (description; *Pieter Faure*, 12157).—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1936, p. 100 (synonym of *afra*).—Gislén, Kungl. Svenska Vet. Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 4 (synonym of *afra*).

Diagnostic features.—The cirri are XX–XLIII, 23–36, 15–18 mm. long; the longest earlier cirrus segments are slightly longer than broad, and the distal segments are slightly broader than long and bear prominent, though blunt, dorsal spines; the lower pinnules are moderately stout and do not differ greatly in size; P_1 is 8–10 mm. long, with 17–25 segments; P_2 is 9.5–13 mm. long, with 22–26 segments; P_3 is 10–13 mm. long, with 22–24 segments; the 20–50 arms are 75–85 mm. long. Except for the greater equality of the lower pinnules and the lesser development of the rugosity of the division series and arm bases this species does not differ in any essential feature from *D. flagellata.*

Description.—The centrodorsal is low hemispherical, 4 mm. in diameter at the base, with the dorsal pole flat 2.5 mm. in diameter. The cirrus sockets are arranged in two irregular marginal rows.

The cirri are about XX, 23–29, from 15 to 18 mm. in length. The first segment is very short, and those following gradually increase in length to the fifth or sixth, which is about as long as broad, and the sixth–ninth or seven–tenth, which are the longest, slightly longer than broad; the succeeding segments gradually decrease in length, those in the distal half of the cirri being slightly broader than long. The ninth or tenth and following segments bear prominent blunt dorsal spines of moderate size.

There are in the type specimen 29 arms about 85 mm. long. IIIBr series are developed externally. The division series are broad with the ventrolateral edges of the component ossicles extended laterally as a thin narrow border the outer edge of which is parallel to the axis of the division series. Synarthrial and articular tubercles are not developed.

P_1 is 8 mm. long, delicate and flagellate, with 21–25 segments, of which the first is twice as broad as long, the third is about as long as broad, and those in the distal half are twice as long as broad. The pinnule tapers rather rapidly in the first four segments, more gradually from that point onward. P_2 is 9.5 mm. long, with 22–25 segments, similar to P_1 but stouter and tapering more evenly. P_3 is 10 mm. long, with 22–24 segments, similar to P_2 and about of the same size. The following pinnules are small. The distal pinnules are very slender, 8 mm. long, with 20 segments. The enlarged lower pinnules are slender and flagellate as in *D. flagellata.*

Notes.—The preceding description is based upon the type specimen from Madagascar in the collection of the Hamburg Museum.

The two specimens from Cape St. André, Madagascar, are young. One of them has exactly 20 arms, one IIIBr series being present and one IIBr series absent. The other has about 20 arms. I originally recorded these as representing a species of *Dichrometra* close to *D. palmata* (=*Lamprometra klunzingeri*). In my paper on the crinoids of the coasts of Africa I said that there is a similar specimen in the British Museum. In my report on the crinoids of that museum, however, I simply listed two small specimens of *D. afra* without comment. The other was recorded in the paper cited above as near *D. flagellata*. Both are from Zanzibar.

Dr. Hubert Lyman Clark thus described *Liparometra multicirra*. The centrodorsal is large and thick, 6 mm. in diameter, with the bare dorsal pole flat or slightly concave, nearly 4 mm. in diameter. The cirri are XLIII, 30–36, cylindrical in cross section basally but distally laterally compressed. The seventh–tenth segments are about as long as broad, or even slightly longer than broad, but the other segments are broader than long. Beginning usually on the tenth or eleventh segment, though on some cirri farther out, there is a median dorsal elevation, which at first is rather blunt but soon has a short compressed tip or even a sharp point. On the last segment this becomes an opposing claw as long as half the lateral width of the segment. The terminal claw is longer than the last segment and is very sharp. The division series are all 2 and are well separated, rounded, and smooth. Low and relatively inconspicuous synarthrial tubercles occur on all the division series. The arms are about 50 in number. They are 75–85 mm. in length. All but two are broken and detached from the disk at or near the base. The brachials are numerous, exceeding 150, the distal ones being quite short. The first syzygy occurs between brachials 3+4. The second syzygy is far out, usually after an interval of more than 21 muscular articulations and often 31–41, rarely before the twentieth brachial. Subsequent syzygies are few and are spaced at very wide intervals.

The lower pinnules are not noticeably larger on the outer side of the arm than on the inner. P_1 is about 9–10 mm. long and is composed of 17–21 segments, of which all but the basal three are longer than broad and all but the basal five or six are cylindrical. P_a is similar to P_1. P_2 and P_b are very similar to P_1 but are noticeably larger, 12–13 mm. long, with 24–26 segments. P_3 and P_c are similar to P_2 and are approximately of the same size, or a little smaller with from one to three fewer segments. P_4 and P_d are distinctly smaller, about equal to P_1. The following pinnules are somewhat smaller, about 7 mm. long. All the basal pinnules are moderately stout at the base but taper to a slightly flagellate tip which is not, however, very slender. The disk is about 23 mm. in diameter and is very deeply incised. The disk membrane is full of crowded small calcareous plates. The color is pale fawn, with the oral surface of the disk and arms very dark brown, almost black. The margins of the food grooves on the disk are black.

I examined the type specimen of *Liparometra multicirra* at the Museum of Comparative Zoology at Cambridge, Mass., and identified it as *Dichrometra afra*, from which it differs in no characters not properly attributable to fuller maturity than is shown by the other known specimens. The centrodorsal is considerably larger, the number of arms is about 50 instead of 29 as in the type specimen of *afra*, and the cirri are somewhat more than twice as numerous. The longest cirri also have more numerous segments.

In both the type specimen of *multicirra* and the type specimen of *afra* the same cirrus segments are the longest and are about as long as or slightly longer than broad, and in both the dorsal processes begin at the same place. The correspondence in the relative proportions of and number of segments in the proximal pinnules is as close as would be expected in two specimens of the same species. In the type specimen of *afra* synarthrial tubercles are not developed, and in the type specimen of *multicirra* they are low and relatively inconspicuous.

Remarks.—Dichrometra afra differs from *D. flagellata*, which it represents in the western Indian Ocean, much as *Capillaster coccodistoma* differs from *C. multiradiata*. It is smaller and more delicate, with usually fewer arms, and lacks the characteristic rugosity of the arm bases and the prominent synarthrial tubercles. P_2 and P_3 are proportionately less enlarged and more delicate and are not greatly longer than P_1.

Localities.—Lamu, Kenya (between Port Durnford and Mombasa); reef opposite the harbor; Dr. Alfred Voeltzkow [Ludwig, 1899; A. H. Clark, 1911].

Zanzibar; Dr. Alfred Voeltzkow [Ludwig, 1899; A. H. Clark, 1911, 1912].

Zanzibar [A. H. Clark, 1911, 1912, 1913] (2, B. M.).

Zanzibar; D. Cyril Crossland [A. H. Clark, 1929] (1, B. M.).

Pieter Faure, 12157; Durnford Point, Zululand, bearing N.W., ¾ W., 12 miles distant; 164 meters; broken shells [H. L. Clark, 1923] (1, South African Mus.).

Cape St. André, Madagascar; about 30 meters; Dr. P. R. Joly, 1901 [A. H. Clark, 1911, 1912] (2, P. M.).

Madagascar; C. Moll [A. H. Clark, 1912] (1, H. M.).

Geographical range.—Coast of east Africa from Lamu, Kenya, southward to Durnford Point, Zuzuland, and Madagascar.

Bathymetrical range.—From the shoreline down to 164 meters.

History.—In his memoir on the echinoderms of the Zanzibar region published in 1899, Prof. Hubert Ludwig recorded *Antedon flagellata* from Lamu and Zanzibar on the basis of three specimens from each locality that had been collected by Dr. Alfred Voeltzkow.

In a paper on the crinoids of the coasts of Africa published early in 1911, I recorded under the heading *Dichrometra* (?species) two young examples "of some species of *Dichrometra*" from Cape St. André, Madagascar, in the Paris Museum, and one from Zanzibar in the British Museum. Under the same heading, repeated, I recorded "a young specimen of some species of *Dichrometra* near *D. flagellata*" from Zanzibar in the British Museum. I also listed *Dichrometra flagellata* from Lamu and Zanzibar, on the basis of Ludwig's records.

In a paper on the crinoids of the Paris Museum published in 1911, I recorded under *Dichrometra* sp. "deux jeunes exemplaires de quelques espèce de *Dichrometra* voisine de *D. palmata*" from Cape Saint-André, Madagascar, that had been collected by Dr. P. R. Joly in 1901 and gave notes on them. These are the two specimens mentioned above.

In 1912 in a paper on the crinoids of the Hamburg Museum I described *Dichrometra flagellata* var. *afra* from a specimen from Madagascar that had been collected by C. Moll. In the synonymy of this new variety I included Ludwig's records of *Antedon flagellata* from Lamu and Zanzibar and my own records of *Dichrometra* sp. from Cape St. André, Madagascar, and Zanzibar.

In my memoir on the crinoids of the Indian Ocean published in 1912, I included ?Madagascar and ?Zanzibar in the range of *Dichrometra flagellata* and recorded *Dichrometra* sp. from Madagascar and also from Zanzibar.

In a paper on the crinoids of the British Museum published in 1913, I recorded two small specimens of *Dichrometra afra* from Zanzibar.

In the key to the species of *Dichrometra* in my memoir on the unstalked crinoids of the *Siboga* Expedition published in 1918, I included *afra*, giving the range as southeastern Africa and Madagascar.

Dr. Hubert Lyman Clark in 1923 described *Liparometra multicirra*, which was based upon a single specimen that had been dredged by the *Pieter Faure* off Durnford Point, Zululand. He said:

> It is with no little hesitation that I put this fine new comatulid in the genus *Liparometra*, but as P_2 and P_3 are of approximately equal size, it seems to me clear that it cannot be placed in either *Dichrometra* or *Lamprometra*, as those genera are diagnosed by their founder, Mr. Austin H. Clark. I am somewhat inclined to question the desirability of recognizing these three very closely allied genera, but here again I must defer to the much wider experience of my friend. The present species is, I think, quite distinct from any previously known form, as the large number of arms and cirri, with their numerous segments, are quite characteristic. The few and widely spaced syzygies is also a noticeable feature.

In 1929 I recorded a small specimen of *Dichrometra afra* that had been collected by Dr. Cyril Crossland at Zanzibar.

DICHROMETRA DÖDERLEINI (de Loriol)

PLATE 58, FIGURE 271; PLATE 59, FIGURES 272, 273

Antedon döderleini DE LORIOL, Rev. Suisse zool., vol. 8, 1900, p. 93 (description; Kagoshima, Japan), pl. 9, figs. 2, *a-i*.—HAMANN, Bronns Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1581 (listed).—A. H. CLARK, Proc. U. S. Nat. Mus., Vol. 34, 1908, p. 469 (listed; collected by Dr. [Ludwig] Döderlein).

Himerometra döderleini A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 317 (Japan).

Dichrometra döderleini A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 149 (synonymy; range); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed), p. 179 (range in east Asia); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga* Exped., 1918, p. 104 (in key; range; *Antedon stylifer* A. H. Clark, 1907, included as a synonym).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 20; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, pp. 4, 5 (French Indo-china), p. 6 (range), p. 14 (Pulo Condor; Misaki; notes).

Dichrometra dofleini A. H. CLARK, Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (southern Japanese species; range and its significance; *nomen nudum*); Proc. Biol. Soc. Washington, vol. 29, 1916, p. 106 (description; Enoura Bay, Suruga Gulf, about 150 m.; most nearly related to *D. ciliata*).

Dichrometra gotoi A. H. CLARK, Unstalked crinoids of the *Siboga* Exped., 1918, p. 105 (in key; range).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 33.

Diagnostic features.—The lower pinnules are slender, P_2 and P_3 being composed of segments most of which are much longer than broad, becoming much elongated distally; P_1 is 8–10 mm. long, with 15–24 segments; P_2 is 15–17 mm. long, with 28–29 segments; P_3 is 18–20 mm. long, with 25–29 segments; the cirri are XXX, 27–35, 20–30 mm. long; the longest proximal cirrus segments are about as long as broad, and those in the distal half of the cirri are slightly broader than long, smooth dorsally, or with small dorsal tubercles or short spines; the 20–47 arms are 100–150 mm. long.

Description.—The cirri are about XXX, 27–28, 30 mm. long. The segments in the proximal half are about as long as broad, and those in the distal half are slightly broader than long with small dorsal tubercles or short spines which begin on the twelfth segment.

The 47 arms are 130 mm. long. The arms are developed in 2,2,2,2 order, or in 2,1,1,2–2,1,1,2 order on each postradial series.

P_2 is 16 mm. long and is composed of 28 segments. P_3 is 18 mm. long, with 27 segments, most of which are twice as long as broad, becoming much elongated distally.

The preceding description is based on the type specimen of *Dichrometra dofleini.*

Notes.—The specimen from eastern Asia has 45 arms 100 mm. long. The cirri are 27 mm. long and are composed of 32–33 segments, of which the outer bear small dorsal tubercles. The division series are bordered by broad lateral extensions whereby they are almost in lateral apposition. P_1 is 10 mm. long, with 24 segments. P_2 is 17 mm. long, with 29 segments. P_3 is 20 mm. long, with 29 segments. P_4 is 13 mm. long, with 21 segments.

Professor de Loriol's description of the type specimen of *Antedon döderleini* is as follows: The centrodorsal is rather thick and is pentagonal in outline. The bare dorsal pole is only 2 mm. in diameter and is covered with small granules. The cirri are irregularly arranged. The cirri are XXXIV, 32–35, from 20 to 25 mm. long and 0.5 to 0.75 mm. in diameter. The segments are cylindrical, not compressed laterally, smooth, longer than broad, and joined exactly end to end without any dorsal projections. The terminal segments are slightly wedge-shaped, the ventral profile being longer than the dorsal. The opposing spine is very small. The terminal claw is a pointed hook. The radials are very short and scarcely visible. The IBr_1 are rectangular, much broader than long, with the dorsal surface convex, and are in lateral contact with those on either side. The IBr_2 (axillaries) are relatively short, much broader than long, with their lateral borders free and slightly flattened. The elements of the IBr series are entirely smooth dorsally and are united by synarthry. The IIBr and IIIBr series are 2, with the elements united by synarthry.

There are 20 long, very slender, very flexible, elegant, and entirely smooth arms which are provided with rather long delicate pinnules. The arms are 150 mm. in length. The number of arms is not the same on the several postradial series. One postradial series bears two IIBr 2 series and a IIIBr series on each of the two IIBr series, giving six arms. The next has only a single IIBr series, which carries a single IIIBr series, giving four arms. The third postradial series bears two IIBr series and no IIIBr series, giving four arms. The fourth has a single IIBr series and no IIIBr series, giving three arms. The fifth bears one IIBr series and one IIIBr series, giving three arms only; but one of the articular faces of the IBr axillary bears a normal ossicle on which is a small axillary ossicle that is not one-third the width of the first and carries two abortive arms 8 mm. long, of which one has an axillary ossicle, giving rise to two still shorter arms. These arms bear very small pinnules. The brachials are strongly convex dorsally, entirely smooth, alternately, regularly, and uniformly tapered toward one side. The two first brachials are slightly flattened laterally. The first syzygy is between brachials 3+4 (or also between brachials 4+5), and the second is from 8 to 13 muscular articulations beyond. The distal intersyzygial interval is 6, 8, 9, or 10 muscular articulations. Sometimes there are two syzygial pairs in succession.

P_1 is 8–9 mm. long, singularly slender, slightly stiffened, and is composed of about 15 segments, which are slender, cylindrical, and much longer than broad. P_a is present. P_2 is at least 15 mm. long, stouter than P_1, with about 28 cylindrical segments, which are at least twice as long as broad except for the first, which are shorter than those following and prismatic. P_3 is almost as long as P_2 and is composed of about 25 segments. P_4 has only 18 segments. From this point onward the pinnules decrease in length, remaining always very slender and delicate. Toward the middle of the arms they have a length of about 10 mm., with a width of only 0.5 mm., and are composed of about 18 segments, which are longer than broad and of which the terminal is a recurved hook; the segments are joined smoothly end to end without any projections. The disk is incised and naked. The color in alcohol is dark brown. Professor de Loriol's note on the fifth postradial series shows that this individual was undergoing adolescent autotomy. Dr. Gislén compared the specimen from Cochinchina with one from Misaki and failed to find any difference.

Remarks.—This species is closely related to *D. ciliata,* from which it appears to differ chiefly in its much more robust build, much stiffer and more wiry, though otherwise exactly similar, elongated proximal pinnules, and, when fully grown, in the greater number of arms, the arms in *D. ciliata* being 34–42. In *D. ciliata* the proximal pinnules appear to be composed of a greater number of segments, P_1 having 29, P_2 having 34, and P_3 having 31 instead of 24, 28–29, and 27–29, respectively, as in *D. döderleini.* In *D. ciliata* P_3 is only 1.5 mm. longer than P_2 instead of 2–3 mm. longer as in *D. döderleini.*

Localities.—Enoura Bay, Suruga Gulf, southern Japan (lat. 35°01′N., long. 138°46′ E.); 150 meters; Prof. Franz Doflein, 1904–'05 [A. H. Clark, 1915, 1916, 1918] (1, Munich Mus. [original No. 337]).

Misaki, Japan [Gislén, 1936].

Kagoshima, Japan [de Loriol, 1900; A. H. Clark, 1907, 1908, 1912, 1913, 1915, 1918].

Eastern Asia (probably the Korean Straits); Captain Suensson (1, C. M.).

Pulo Condor, Cochinchina; littoral; Dr. C. Dawydoff [Gislén, 1936].

Geographical range.—Southern Japan from Sagami Bay westward to the Korean Straits, and southward to Cochinchina.

Bathymetrical range.—From the shoreline down to 150 meters.

History.—This species was first described, with figures, under the name of *Antedon döderleini* by Prof. Percival de Loriol in 1900. His specimen came from Kagoshima, Japan.

In my first revision of the old genus *Antedon,* published in 1907, *Antedon döderleini* was transferred to the new genus *Himerometra.*

In a list of the crinoids of Japan published by me on July 15, 1908, *Himerometra döderleini* was included. In a list of the names that had been applied to recent crinoids, published on August 25, 1908, I gave Dr. [Ludwig] Döderlein as the collector of the type specimen of *Antedon döderleini.* Although the species was named for Professor Döderlein by Professor de Loriol, there is no evidence that the type specimen came from the collection of comatulids made by the former in Japan.

In my memoir on the crinoids of the Indian Ocean published in 1912, *Dichrometra döderleini* was listed, and the synonymy and range were given. It had been omitted from the list of species assigned to *Dichrometra* when that genus was established in 1909, but it was included in the list of names under *Dichrometra* in my revision of the family Mariametridae published in 1913.

In 1915 I included the name *Dichrometra dofleini*, a *nomen nudum*, in a list of the comatulids occurring along the coasts of China and Japan. The specimen upon which the new name was based was one that had been collected by Prof. Franz Doflein, who had kindly sent me for study his entire collection of Japanese comatulids. The depth of the habitat was given as 83 fathoms.

In 1916 *Dichrometra dofleini* was formally described from the specimen mentioned above.

In my report on the unstalked crinoids of the *Siboga* expedition published in 1918, the name *gotoi* appeared in the key to the species of *Dichrometra*. The name *Dichrometra gotoi* was based upon the type specimen of *D. dofleini*, so that *gotoi* is a pure synonym of the earlier *dofleini*. In a footnote under the name *döderleini* in this same key, *Antedon stylifer* is erroneously given as a synonym.

In 1936 Dr. Torsten Gislén recorded a specimen from Cochinchina, greatly extending the known range of the species.

DICHROMETRA CILIATA A. H. Clark

PLATE 57, FIGURES 263, 264; PLATE 58, FIGURES 265–268

Dichrometra ciliata A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 319 (detailed description; off Gopalpore, 30–38 fathoms; compared with *D. flagellata*); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed), vol. 29, 1916, p. 106 (most nearly related to *D. dofleini*); Unstalked crinoids of the *Siboga* Exped., 1918, p. 105 (in key; range); Rec. Indian Mus., vol. 34, pt. 4, 1932, p. 551 (listed), p. 558 (*Investigator* station 549; notes).—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.

Diagnostic features.—The lower pinnules are slender, P_2 and P_3 being composed of segments that from the fifth onward are longer than broad, becoming three times as long as broad distally; P_1 is 11.5 mm. long, with 29 segments; P_2 is 17 mm. long, with 34 segments; P_3 is 18.5 mm. long, with 31 segments; the cirri are XXVII, 29–35 (usually about 33), 30 mm. long; small but prominent dorsal spines are developed from the tenth–thirteenth segment onward; the 34–42 arms are 110–120 mm. long.

Description.—The centrodorsal is moderate in size, with the dorsal pole concave, 2 mm. in diameter.

The cirri are XXVII, 29–35 (usually about 33), 30 mm. long. Small but prominent dorsal spines are developed from the tenth to thirteenth segments onward.

The 34–42 arms are 110 to 120 mm. in length. The division series and arms resemble those of *D. flagellata* but are smoother and without any trace of synarthrial tubercles.

P_1 is 11.5 mm. long, very slender, with 29 segments, of which the second and third are about as long as broad, the fourth tapers somewhat distally, and the fifth and following are half again as long as broad, soon becoming twice as long as broad and three times as long as broad distally. P_2 is 17 mm. long, no stouter than P_1 basally but tapering more gradually, very slender, slightly stiffened, with 34 segments, of which the third is about as long as broad, the fifth is half again as long as broad, the tenth is twice as long as broad, and the terminal are three times as long as broad. P_3 is 18.5

mm. long, with 31 segments, resembling P_2 but just perceptibly stouter. P_4 is 11.5 mm. long, with 21 segments, as stout basally as P_1 but tapering more evenly. P_5 is 6.5 mm. long, with 16 segments. P_6 is 5 mm. long, with 12 segments. P_7 is 4.5 mm. long, with 12 segments, not stiffened like the preceding pinnules. The following pinnules are similar. The distal pinnules are 7 mm. long, with 18 segments.

The division series are moderately separated laterally.

In alcohol the dorsal pole of the centrodorsal and the division series and arm bases as far as the third brachial are light grayish, thickly sprinkled with minute spots of white. The first syzygial pairs and the adjacent portions of the second and fifth brachials are blackish brown. The remainder of the arms is white, with narrow black bands at intervals of about 5 mm. The entire ventral perisome is olive-green, with numerous small white spots. The cirri are white.

Notes.—The five specimens from off Gopalpore have 34, 36, 39, 40, and 42 arms.

In the specimen from *Investigator* station 549 the 40 arms are 90 mm. long. The color is white; the first syzygial pair is deep purplish brown, the syzygial pairs collectively forming a conspicuous narrow ring about the central portion of the animal; the following syzygial pairs and the immediately adjacent proximal and distal brachials are also deep brownish purple.

Remarks.—This species appears to be most nearly related to *D. flagellata*, from which it may be easily distinguished by the much longer and much slenderer proximal pinnules, which are composed of very much longer segments, the small size of P_4, which is as small as P_1 instead of being as large as P_2 or P_3, and by the entire absence of the rugose appearance so characteristic of *D. flagellata.*

Localities.—Bengal Fisheries steamer *Golden Crown*; off Gopalpore; 54–69 meters [A. H. Clark, 1912, 1913, 1918] (5, U.S.N.M., 35225, 35258; I.M.).

Investigator station 549; Mergui Archipelago, northwest of King Island (lat. 12°48′00″ N., long. 98°16′10″ E.); 44 meters; mud, sand, and shells; October 21, 1913 [A. H. Clark, 1932] (1).

Geographical range.—Bay of Bengal, from Gopalpore on the west to the Mergui Archipelago on the east.

Bathymetrical range.—From 44 to 54 (?69) meters.

History.—This species was originally described in 1912 from five specimens that had been dredged by the Bengal steam trawler *Golden Crown* off Gopalpore. Later another specimen was dredged by the *Investigator* at station 549.

Genus MARIAMETRA A. H. Clark

Antedon (part) BELL, Proc. Zool. Soc. London, 1894, p. 396, and following authors.

Himerometra (part) A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, pp. 237, 308.

Dichrometra (part) A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13.

Mariametra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 144 (diagnosis; genotype *Himerometra subcarinata* A. H. Clark, 1908), p. 176 (referred to the Mariametrinae); Mem. Australian Mus., vol. 4, pt. 15, 1911, p. 725 (absent from Australia); Proc. Biol. Soc. Washington, vol. 25, 1912, p. 24 (ornamentation of division series compared with that of *Zygometra punctata*); Crinoids of the Indian Ocean, 1912, p. 9 (absent from Australia), p. 11 (occurs west to the Andamans); p. 22 (distribution in detail), p. 57 (in key), p. 139 (original reference; type); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 141 (referred to the Mariametridae), p. 142 (in key), p. 144 (synonymy; genotype; range; depth; included species); Unstalked crinoids of the

Siboga Exped., 1918, p. 98 (in key; range), p. 107 (key to the included species).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 84 (syzygies), p. 230 (disk), p. 235.

Diagnosis.—A genus of Mariametridae in which the lateral portions of the division series are ornamented with more or less closely crowded small tubercles or spinules; P_3 is the longest and largest pinnule, usually markedly longer than P_2 or P_4, though sometimes not greatly longer (and in young or undeveloped individuals or on undeveloped arms occasionally shorter), and tapers gradually to a delicate tip; the division series are usually in close lateral apposition with more or less flattened sides, less commonly just in contact or even free laterally with the sides slightly or even not at all flattened; the cirri are of moderate length, with 24–40 segments, of which the outer are simply carinate dorsally or bear more or less strongly developed dorsal spines or tubercles.

Geographical range.—Southern Japan from the Oki Islands in the Sea of Japan to Tokyo Bay and southward to Amboina, the Kei Islands, Timor, Flores, and Sapeh Strait, between Sumbava and Komodo, and westward to the Mergui Archipelago.

Bathymetrical range.—From 40 to 153 meters.

Remarks.—As understood herein the genus *Mariametra* includes five species, three of which, *delicatissima*, *tuberculata*, and *tenuipes*, are known from only a single specimen each. The two best-known species, *subcarinata* and *vicaria*, seem to be very distinct, but the relationships of the other three are more or less obscure.

Except for the occurrence of spinous or tubercular ornamentation along the sides of the division series, which is a more or less trivial feature, and the greater slenderness correlated with the smaller size, there are no tangible differences between the species of *Dichrometra* and those assigned to the genus *Mariametra*. The species of *Mariametra* are simply rather small species of the *Dichrometra* type inhabiting in general rather deeper water than the species of *Dichrometra*. While the species of *Dichrometra* are mainly littoral, the species of *Mariametra* do not approach within 40 meters of the surface; but, on the other hand, the greatest depth at which a species of *Mariametra* (*delicatissima*) has been found is 153 meters, though a species of *Dichrometra* (*afra*) is known from 164 meters.

History.—The genus *Mariametra*, with the genotype *Himerometra subcarinata* A. H. Clark, 1908, was established by me in a paper on new recent Indian crinoids published in 1909 in the following terms:

> The form which I described under the name of *Himerometra subcarinata* differs markedly from all the other species in the genus *Dichrometra*, where I had tentatively placed it, in having a delicate narrow carinate line in the middle of the dorsal surface of the division series and first two brachials, and in having the sides of the division series thickly covered with fine granulations forming a triangular figure in each interradial area, with the apex at about the level of the last axillary, something similar to the ornamentation found in certain species of *Crinometra*. There are also differences in the cirri and in the pinnules, and the surface of the disk adjacent to the ambulacra is strongly plated. It did not seem wise to create a genus for this single aberrant species, as it was then impossible to judge of the value of the characters exhibited, they not being met with in any other species of the Himerometridae. The Indian collection, however, contains another species possessing the same general features which separate *subcarinata* from the remaining species of *Dichrometra*, though differing widely in its details, and I have now no hesitation in creating a genus for these two peculiar forms, which I propose to call *Mariametra*.

The new Indian species referred to was described as *Mariametra margaritifera* (=*vicaria*).

In July 1912, I described *Mariametra tenuipes* and *M. tuberculata* from the *Siboga* collection and compared the latter with *M. delicatissima* (=*Antedon delicatissima* A. H. Clark, 1907).

In my memoir on the crinoids of the Indian Ocean published later in 1912 I redescribed Bell's *Antedon vicaria* under *Mariametra vicaria.* I also redescribed and figured my own *Mariametra margaritifera* and listed *M. subcarinata,* giving the synonymy and range.

In 1913 I established the family Mariametridae and as the nominal species under the genus *Mariametra* listed *delicatissima, margaritifera, subcarinata, tenuipes, tuberculata,* and *vicaria.*

KEY TO THE SPECIES IN THE GENUS MARIAMETRA

a^1. About 40 arms 60–80 mm. long; no median dark stripe on division series or arms; lateral ornamentation on the division series fine and more or less obscure; P_3 and P_4 similar and of the same length, 10–15 mm. long, with 16–20 segments, stouter and stiffer than the other proximal pinnules and standing out prominently from them; cirri 15–22 mm. long, with 30–40 (usually 30–35) segments (southern Japan from Oki Islands in Sea of Japan to Tokyo Bay, and southward to Formosa [Taiwan] channel; 40–108 meters) ---------- **subcarinata** (p. 568)

a^2. Not more than 30 arms; a narrow median dark stripe on division series or arms or both; ornamentation more conspicuous; P_4 shorter than P_3.

  b^1. Outer cirrus segments broader than long, or at least not longer than broad, with long sharp dorsal spines; 18–30 arms 35–65 mm. long; cirri XXI–XXIII, 29–36, 15–23 mm. long (from Macclesfield Bank south to Amboina, the Kei Islands, and Sapeh Strait, and westward to Mergui Archipelago; 55 [?36]–100 meters) ---------- **vicaria** (p. 573)

  b^2. Outer cirrus segments longer than broad, though on some cirri a few of the outermost may be about as long as broad, simply carinate dorsally, or with slight tubercles or blunt spines.

    c^1. About 40 cirrus segments; about 30 arms 70 mm. long; P_3 much the longest pinnule, 11 mm. long with about 20 elongated cylindrical segments (Linschoten Islands, off southwestern Japan; 153 meters) ---------- **delicatissima** (p. 579)

    c^2. Not more than 30 cirrus segments.

      d^1. Cirri about one-fourth length of arms, with longest segments twice as long as broad; sides of ossicles of division series coarsely tubercular; a faint median line of pinkish on proximal half of arms, but none on division series (off western Flores; 69–91 meters) **tuberculata** (p. 580)

      d^2. Cirri approximately half arm length, with longest segments about three times as long as median width; sides of ossicles of division series with irregular and closely crowded short blunt spines; a median line of dark purple on division series and arms (off Timor; 73 meters) ---------- **tenuipes** (p. 582)

MARIAMETRA SUBCARINATA (A. H. Clark)

PLATE 60, FIGURES 276–278

[See also vol. 1, pt. 1, fig. 260 (centrodorsal), p. 255; fig. 343 (cirrus), p. 287; fig. 476 (radial pentagon), p. 361; pt. 2, figs. 47, 48 (radial pentagon), p. 26; fig. 247 (arm), p. 199; fig. 684 (arm base), p. 338; figs. 722, 723 (disk), p. 346.]

Himerometra subcarinata A. H. CLARK, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 237 (description; *Albatross* station 4880), p. 308 (Tokyo Gulf; Sagami Bay), p. 523 (listed); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 144 (type of *Mariametra*).

Dichrometra subcarinata A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 13 (listed).

Mariametra subcarinata A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 145 (arms compared with those of *M. margaritifera*); Proc. U. S. Nat. Mus., vol. 36, 1909, p. 647 (ornamentation of sides of division series compared with that in *Crinometra insculpta*); Vid. Medd. Naturh. Foren. København, 1909, p. 171 (near the Goto Islands, 40 fathoms; off the Goto Island, 22 fathoms), p. 172 (off the Goto Island, 40 fathoms; Formosa Channel, 35 fathoms; also specimens with no locality; descriptions of the specimens; 4-rayed specimen from Formosa Channel); Crinoids of the Indian Ocean, 1912, p. 143 (synonymy; range); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed), p. 179 (range in east Asia); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga* Exped., 1918, p. 108 (in key; range).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 74, 78 (syzygies), fig. 72, p. 75 (syzygial face); Vid. Medd. Dansk Naturh. Foren., vol. 83, 1927, p. 2 (Mortensen's stations 12, 14; 47 m.), p. 22 (stations 12, 14; notes), p. 68 (listed), figs. 11–14, p. 27; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.

Diagnostic features.—The arms are about 40 in number, 60–80 mm. long; there is no median dark stripe on the division series or arms; the lateral ornamentation on the division series is fine and more or less obscure and difficult of detection; P_3 and P_4 are similar and of the same length, 10–15 mm. long, with 16–20 segments, stouter and stiffer than the other proximal pinnules, from which they stand out prominently; the cirri are XXX–L, 30–40 (usually 30–35), 15–22 mm. long.

Description.—The centrodorsal is hemispherical, with a comparatively small strongly convex bare polar area.

The cirri are XXX–L, 30–40 (usually 33–35), 15–22 mm. long. The first segment is very short, and those following become progressively longer to the sixth or seventh, which is about as long as broad or slightly longer than broad, then remaining fairly uniform to the end of the cirri or becoming very slightly shorter distally. Some of the cirri have the three or four segments following the fifth slightly longer than broad, but the length does not reach one and one-half times the width. From the eighth or tenth onward the segments bear prominent dorsal spines, which at first are borne on their distal ends but later gradually move to a more central position. The opposing spine scarcely reaches half the width of the penultimate segment in height. The terminal claw is moderately stout and well curved, and is about equal to the penultimate segment in length.

The radials are entirely concealed, or their anterolateral angles are visible in the angles of the calyx. The IBr_1 are short, about three times as broad as long, and are in close lateral apposition. The IBr_2 (axillaries) are broadly pentagonal, almost triangular, about twice as long as the IBr_1. The IIBr and IIIBr series are 2, similar to the IBr series but with their component elements proportionately rather longer. The ossicles immediately following each axillary are almost completely united interiorly. The division series and the first two to six or seven brachials have a very delicate raised median line which gives them a very characteristic appearance. The lateral portions of the dorsal surface of the division series are occupied by a rather broad band of fine and closely set granulations that narrows distally and disappears on the last axillary or first brachial. This ornamentation is very evident on dried specimens, but it may entirely escape detection if the specimen be wet. It was entirely overlooked at the time the species was originally described. The postradial series and one or two of the earliest brachials are in close apposition and are sharply flattened laterally.

The 40 arms are 80 mm. long. The two first brachials are slightly wedge-shaped, about twice as broad as long. The following six brachials are oblong, about twice as broad as long, and those succeeding are obliquely wedge-shaped or almost triangular, much broader than long, gradually becoming wedge-shaped again and oblong distally.

Syzygies occur between brachials 3+4, again from between brachials 21+22 to between brachials 31+32 (usually about brachials 26+27), and distally at intervals of from 5 to 15 muscular articulations.

P_1 is 7 mm. long, somewhat stiffened, and is composed of 15–20 segments, of which the first three are about as long as broad and more or less carinate, often strongly so as in the type specimen, the fourth is trapezoidal and somewhat carinate, and the remainder are moderately elongate. P_2 is 11 mm. long, with 20 segments, of which the first three are about as long as broad and carinate, and the remainder are elongate, about two and one-half times as long as broad. P_3 and P_4 are similar to each other and equal in length, 15 mm. long, with 18–20 segments, of which the first two are as in P_2, and the remainder are three or more times as long as broad. P_2, although longer than P_1, is about equal to the latter in general proportions, but P_3 and P_4 are stouter and stiffer and stand out prominently from the other pinnules. P_5 is 8 mm. long and is most nearly like P_1. The following pinnules are 5 mm. long, small and weak, with 11 comparatively short segments. The distal pinnules are short, 6 mm. long, with about 15 segments, of which the first two are not so long as broad and the remainder are longer than broad, becoming about twice as long as broad distally.

The type specimen is grayish, with occasional spots of purple on the arms; the dorsal skeleton and the cirri are light grayish tinged with yellow.

The specimens in the Springer collection, preserved in formalin, are uniform deep purplish brown, the cirri lighter.

Notes.—In the type specimen from *Albatross* station 4880 the centrodorsal is thick discoidal, with the cirri arranged in two irregular rows. The cirri are about XL, 33–35, the longest 22 mm. long. The longest cirrus segments are slightly longer than broad. The anterolateral angles of the radials are just visible in the interradial angles of the calyx. P_1 is 7 mm. long, with 15 segments. P_2 is 11 mm. long, with 20 segments. P_3 and P_4 are similar and equal in length, 15 mm. long, with 18–20 segments. P_5 is 8 mm. long. The elongate lower pinnules are comparatively slender but stiff and wiry.

In the specimen from Dr. Th. Mortensen's Pacific Expedition station 12 the centrodorsal is 3.2 mm. in diameter, with the bare dorsal pole slightly convex. The cirri are XXXIV, 29–37, from 17 to 19 mm. long. The sixth–fourteenth segments are the longest, and are slightly longer than broad. A dorsal keel is developed from the sixth segment onward. The 37 (?+1 broken) arms are 60 mm. long. The division series are all 2. A single IVBr series is present. A ventrolateral granulation is present from the IBr_1 to the first brachial, and there is a distinct median carination on the division series and the first 8 to 10 brachials. P_1 is 6.5 mm. long, with 18 segments. P_2 is 7.5–9.8 mm. long, with 19–21 segments. P_3 is 12.5 mm. long, with 20 segments. P_4 is 13.8 mm. long, with 20 segments. P_5 is 13 mm. long, with 20 segments. P_6 is 5.2 mm. long, with 15 segments. The color is violet-red.

Of the three specimens from near the Goto Islands in 73 meters the largest may be described as follows: The centrodorsal is a thick disk, with the moderately large bare polar area slightly convex and the cirrus sockets arranged in two and a partial third crowded and irregular, more or less alternating, rows. The cirri are XXXV, 31–35 (usually nearer the latter), from 20 to 25 mm. long. The first segment is short, and those following gradually increase in length to the sixth–eleventh or fourth–fourteenth, which are about as long as broad or somewhat longer than broad, and then very gradually decrease, though never becoming much broader than long. Rather prominent dorsal spines are developed from the tenth segment onward. The opposing spine is rather short and blunt. The 39 arms are 65 mm. long. The lateral portions of the dorsal surface of the division series bear a rather broad band of fine granulations which narrows anteriorly, disappearing on the last axillary or first brachial. A much narrower band is found between the IIBr series, and traces of a similar band between the IIIBr series. One of the two smaller specimens possesses two IVBr series, both externally developed.

The specimen from off the Goto Islands in 40 meters is small.

In one of the two specimens from Dr. Th. Mortensen's Pacific Expedition station 14 the cirri are XXXI, 25–39, from 13 to 20 mm. long. Dorsal prominences are developed from the eleventh segment onward. The 39 arms are 60 mm. long. There is a weak median carination on the arm bases. The lateral portions of the IBr and IIBr series have a slight granulation. The distal intersyzygial interval is 9–18 muscular articulations. P_1 is 5.5 mm. long, with 16 segments. P_2 is 9.5 mm. long, with 19 segments. P_3 is 10.5 mm. long, with 16 segments. P_4 is 9.5 mm. long, with 16 segments. P_5 is 5.5 mm. long, with 14 segments. P_6 is 3.5 mm. long. The pinnules following become longer again. The disk is 10 mm. in diameter, rather deeply incised, and with coarse granulation.

In the second specimen from station 14 the cirri have 26–34 segments and are 10–15 mm. long. The 36+ (probably 40) arms have the second syzygy at about the fortieth brachial, and the distal intersyzygial interval is 9–12 muscular articulations. P_1 is 6.5 mm. long, with 16 segments. The pinnules following are more or less broken. P_2 is, however, slightly stouter than P_3 and P_4.

Gislén said that the cirri in the two specimens last mentioned are slightly more slender than in the specimen from Mortensen's station 12 and provided with smaller dorsal spines. P_3, P_4, and P_5, which in the specimen from station 12 are larger than P_1 and P_2, are only inconsiderably larger, or are even smaller. Gislén remarked that this is evidently due to these pinnules not attaining their full size until the animal is nearly full grown.

The eight specimens from Sagami Bay and Tokyo Gulf are all similar. They resemble the type specimen from *Albatross* station 4880 but are very dark, nearly black.

The specimen without locality is small. It has a single externally developed IVBr series.

Abnormal specimen.—The specimen from the Formosa (Taiwan) Channel is small, though well developed. It has only four rays, which bear 7, 4, 3, and 6 arms, respectively. As the disk is lacking, orientation and the determination of the missing ray are impossible. The specimen is very imperfect. The longest cirrus stump remaining, broken off at the nineteenth segment, is 12 mm. long. The longest arm, broken off at the tenth brachial following a IIIBr series, is also 12 mm. long.

Localities.—*Albatross* station 4880; eastern channel of the Korean Strait, in the vicinity of the Oki Islands; Oki Shima bearing S. 79° W., 7.5 miles distant (lat. 34°16′00″ N., long. 130°16′00″ E.); 108 meters; fine gray sand and broken shells; August 2, 1906 [A. H. Clark, 1908, 1909, 1912, 1913, 1915, 1918] (1, U.S.N.M., 22666).

Dr. Th. Mortensen's Pacific Expedition, 1914–1916; station 12; off Kiu Shiu, Japan (lat. 33°51′ N., long. 130°03′ E.); 47 meters; shells; May 18, 1914 [Gislén, 1927].

Korean Straits near the Goto Islands (lat. 33°10′ N., long. 129°18′ E.); 73 meters; Captain Suensson, September 17, 1900 [A. H. Clark, 1909, 1912, 1913, 1915, 1918] (3, C. M.).

Korean Straits, off the Goto Islands (lat. 33°09′ N., long. 129°18′ E.); 73 meters; Schönau, May 23, 1898 [A. H. Clark, 1909, 1912, 1913, 1915, 1918] (1, C. M.).

Korean Straits, off the Goto Islands (lat. 33°00′ N., long. 129°24′ E.); 40 meters; Schönau, August 16, 1891 [A. H. Clark, 1909, 1912, 1913, 1915, 1918] (1, C. M.).

Dr. Th. Mortensen's Pacific Expedition, 1914–1916; station 14; Nagasaki, Kiu Shiu, Japan; 1914 [Gislén, 1927].

Sagami Bay, Japan (lat. 34°47′ N., long. 138°44′ E.); 102 meters; Alan Owston, August 20, 1902 [A. H. Clark, 1908, 1909, 1912, 1913, 1915, 1918] (1, U.S.N.M., 35259 [original No. 7173]).

Sagami Bay, Japan (lat. 35°02′ N., long. 138°52′ E.); 91 meters; Alan Owston, August 6, 1902 [A. H. Clark, 1908, 1909, 1912, 1913, 1915, 1918] (4, U.S.N.M., 35229 [original No. 7016]).

Uraga Channel, entrance to Tokyo Gulf; 55 meters; Alan Owston, May 17, 1901 [A. H. Clark, 1908, 1909, 1912, 1913, 1915, 1918] (2, U.S.N.M., 35228, 35250 [original No. 6052]).

Uraga Channel, entrance to Tokyo Gulf; 46 meters; Alan Owston, May 26, 1901 [A. H. Clark, 1908, 1909, 1912, 1913, 1915, 1918] (1, U.S.N.M., 25230 [original No. 6067]).

Formosa (Taiwan) Channel; 64 meters; Captain Suensson, November 23, 1901 [A. H. Clark, 1909, 1912, 1913, 1915, 1918] (1, C. M.).

No locality [A. H. Clark, 1909, 1912, 1913, 1915, 1918] (1, C. M.).

Geographical range.—Southern Japan from the Oki Islands in the Sea of Japan to Tokyo Bay, and southward to the Formosa (Taiwan) Channel.

Bathymetrical range.—From 40 to 108 meters.

History.—This species was first described by me in 1908 as *Himerometra subcarinata* from a specimen dredged by the *Albatross* at station 4880. Two months later I recorded and gave notes on seven specimens of *Himerometra subcarinata* from Sagami Bay and Tokyo Gulf that had been collected by Alan Owston of Yokohama in his yacht the *Golden Hind*. Mr. Owston's collection of crinoids had been purchased and deposited in the United States National Museum by Frank Springer.

In my revision of the family Himerometridae published in 1909, *subcarinata* was placed in the new genus *Dichrometra*. Later in 1909, in a paper on new recent Indian crinoids, the new genus *Mariametra* was established with *Himerometra subcarinata* as the genotype. I said that the form I had described under the name *Himerometra subcarinata* differs markedly from all the other species in the genus *Dichrometra*, where I had tentatively placed it, in having a delicate narrow carinate line in the middle of the dorsal surface of the division series and first two brachials, and in having the sides of the division series thickly covered with fine granulations, forming a triangle in each interradial area with the apex at about the level of the last axillary, something similar to the ornamentation found in certain species of *Crinometra*. No mention had been made of this granular ornamentation in the original description. In the same paper the arms of *subcarinata* were compared with those of a new species, *Mariametra margaritifera* (=*M. vicaria*).

Toward the end of 1909 in a paper on the crinoids of the Copenhagen Museum, I recorded and gave notes on five specimens of *Mariametra subcarinata* from three different localities in the Korean Straits and on one without locality, and described a 4-rayed individual from the Formosa Channel. In this paper I described the granular ornamentation on the division series and said that at the time I described this species this very noticeable character in some unexplained way was overlooked, though I found it to be one of the best means of identifying the species. I said that on reexamining the type specimen I found this feature to be quite as marked in that as in the specimen under consideration, though because of the very light color of the type specimen not quite so evident at first glance.

In my memoir on the crinoids of the Indian Ocean published in 1912, I listed *Mariametra subcarinata* and gave its synonymy and range, and the range was further discussed in 1913 and again in 1915.

In my memoir on the unstalked crinoids of the *Siboga* expedition published in 1918, I included *subcarinata* in the key to the species of the genus *Mariametra* and gave its range.

In 1924 Dr. Torsten Gislén discussed various structural features of this species, and in 1927 he recorded and described three specimens that had been collected by Dr. Th. Mortensen in southern Japan.

MARIAMETRA VICARIA (Bell)

[See also vol. 1, pt. 2, fig. 129 (arm base), p. 79; fig. 197 (lateral view), p. 125; figs. 478, 479 (pinnule tip), p. 269; fig. 721 (disk), p. 346.]

Antedon vicaria Bell, Proc. Zool. Soc. London, 1894, p. 396 (Macclesfield Bank; 30–40 fathoms), p. 400 (in key; *Spinifera* group; description).—A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 499 (not identifiable; in reality a member of *Palmata* group); Crinoids of the Indian Ocean, 1912, p. 38 (=*Mariametra vicaria*).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, 1912, p. 309 (in *Spinifera* group; history; discussion), p. 310 (insufficiently described).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank).

Antedon ?variispina Bell, Proc. Zool. Soc. London, 1894, p. 396 (Macclesfield Bank, 50 fathoms).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 38 (identity); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 88 (identity).—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank).

Mariametra margaritifera A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 145 (description; 2 miles off Great West Torres Island); Crinoids of the Indian Ocean, 1912, p. 141 (synonymy; detailed description; locality), fig. 16, p. 141; A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed).

Mariametra vicaria A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 38 (identity of previous records); p. 142 (synonymy; detailed description of the 2 known specimens; locality); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 30 (published references to specimens in the B. M.; localities); Unstalked crinoids of the

Siboga Exped., 1918, p. 108 (in key; range; synonymy; station 49*a*), p. 271 (listed).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank); p. 6 (range).

Diagnostic features.—The arms are 18–30 in number, 35–65 mm. long; the division series and arm bases have a narrow very dark median stripe; the cirri are XXI–XXIII, 29–36, 15–23 mm. long; the longest segments are about twice as long as broad, and the outer segments are slightly broader than long, with long sharp dorsal spines.

Description.—The centrodorsal is discoidal and usually rather small.

The cirri are XXI–XXIII, 29–36, 15–23 mm. long. The first segment is very short, the second is twice as broad as long, the third is slightly longer than broad, and the fifth–seventh or –eighth are the longest, about twice as long as broad. The segments following decrease in length so that the outer, from the ninth or tenth onward, are slightly broader than long. The tenth and following segments bear long sharp dorsal spines, which are directed obliquely distally.

The radials are short, about six times as broad as long, and are gently convex proximally and correspondingly concave distally. The IBr_1 are short, oblong, somewhat over four times as broad as long, and in lateral apposition. The IBr_2 (axillaries) are short, almost or quite triangular, two and one-half or three times as broad as long, and in lateral apposition. The sides of the elements of the division series are from slightly to rather broadly flattened. In some cases the radials and the portion of the centrodorsal above the proximal row of cirrus sockets are evenly and thickly covered with high small tubercles resembling those on the dorsal pole of the centrodorsal, this tubercular modification of the dorsal surface of the segments extending distally in the interradial angles, occupying the lateral third of the IBr_1 and IBr_2 and the IIBr series, thence diminishing in width and disappearing on the second brachial; the inner borders of the IIBr series are similarly modified. In other cases the distal border of the radials is finely beaded, and the dorsal surface carries a few well-spaced low tubercles, while the lateral borders of the dorsal surface of the elements of the division series are thickly beset with short papillae or short spines, this ornamentation along the articulations between the axillaries and the ossicles preceding running inward halfway to the median line in the form of a broad triangle. In still other cases the lateral portions of the division series may be converted into a spongy-looking mass, which causes their edges to appear denticulate. The IBr series have a low and narrow, but prominent, and more or less tubercular median keel or row of tubercles. This is much less marked on, or altogether absent from, the IIBr series and first two brachials, although it is sometimes traceable to the lowest of the triangular brachials, or even to the arm tips. The elements of the IBr and IIBr series and the oblong proximal brachials have prominently everted dentate proximal and distal ends; as the brachials become wedge-shaped and triangular the everted dentate ends become gradually lower, transforming into a rather prominent finely spinous overlap that slowly dies away distally. When developed IIIBr series are always external.

The 18–30 (usually 24–30) arms are 30–65 mm. long. The proportions of the brachials are the same as in *M. subcarinata.*

P_1 is 4–5 mm. long, with 12–18 segments. The first four segments are broad, so that the pinnule is moderately stout basally, but from the fifth segment onward it is slender and flagellate. The first segment is from about as long as broad to slightly broader than long, the second is also from about as long as broad to slightly broader than long, and the third is about as long as broad; the fourth segment tapers distally and is longer than the width of the proximal end. The fifth and following segments are twice as long as broad, becoming three or four times as long as broad distally. The second–fourth segments have a narrow knifelike keel that disappears at the distal end of the latter.

P_2 is 6–7 mm. long, with 16–20 segments. It is slender, but stouter and stiffer than P_1, tapers more gradually, and is composed of proportionately longer segments, which at first are about as long as broad but become three or four times as long as broad distally. The second–fourth segments are narrowly but conspicuously carinate.

P_3 varies from about the same size as P_2 and similar to it in specimens not fully developed to markedly longer and stouter than P_2. In the specimen from the Danish Expedition to the Kei Islands station 54, P_3 is 10 mm. long, with 18 segments, and is stouter than P_2. The first segment is about as long as broad, the second is slightly broader than long, the third is about one-third again as long as broad, and the fifth and following are four or five times as long as broad. The second and third segments, and the basal portion of the fourth, are carinate.

P_4 is 3–7.5 (usually 3–4) mm. long, small, weak, and flexible, more slender than P_3 and tapering more rapidly, with 13–15 segments, of which the first two are slightly broader than long, the third is one-third again as long as broad, the fifth is twice as long as broad, and those following are three times as long as broad, becoming longer distally. The second and third segments are carinate.

The pinnules immediately following are small, weak, and flexible, 3–4 mm. long, with about 13 segments, of which the first–third are more or less evidently carinate. P_4 may resemble these pinnules or be intermediate between them and P_3.

The distal pinnules are delicate and are about 5 mm. long.

Notes.—Professor Bell thus described *Antedon vicaria:*

> Bidistichate, with wall-sided radials, strong pinnules, and about 30 cirrus-joints, of which the more distal are spiny. With so much resemblance to *A.* [=*Ptilometra*] *macronema*, it has shorter cirri (20 mm.) and has [=less] numerous (30) [cirrus-] joints. Arms probably about 25 in number. Neither radial nor distichal palmars [=axillaries] syzygial. Cirri white, arms white with middle dorsal line of purple, pinnules purplish.
>
> Spread 100 mm. [that is, the arms 50 mm. long]; diameter of deeply incised disc 4 mm.

I examined Bell's type specimen at the British Museum in 1910. The cirri are XXIII, 29–31 (usually 29), slender, 20 mm. long. Long, sharp dorsal spines are developed from the ninth or tenth segment onward. The longest cirrus segments, just before the development of the dorsal spines, are about twice as long as broad. The 24 arms are 60 mm. long. The dorsolateral ornamentation of the division series and arm bases occupies exactly the same areas as in *M. subcarinata*, but it is much more prominent and more irregular. Instead of having a finely and evenly tuberculated surface the sides of the postradial series are converted into a spongy looking mass, which causes the edges of the rays to appear denticulate. The median keel on the division series and brachials is much higher than it is in *M. subcarinata.* The arms and division series have a narrow dark-purple median line. When developed the IIIBr series are always external. The disk is covered with small plates.

The specimen from the Macclesfield Bank in 91 meters has the cirri XXIII, 33–36, 23 mm. long. Dorsal spines are developed from the tenth segment onward. In this specimen the cirrus segments are not so long proportionately as in that preceding. One of the cirri is regenerating the distal portion. There are between 25 and 30 arms 65 mm. long. Very fine spines are developed in the areas of ornamentation. These little fuzzy spines cover the radials and a small part of the proximal edge of the IBr_1, extending thence upward interradially. At the articulations the ornamentation extends somewhat dorsalward, following along the articular divisions, and it may even narrowly bridge the division series at the synarthries, a condition not occurring so markedly in the other specimen.

In both individuals the division series are sharply flattened laterally, and both have the same median carination of the division series and lower brachials, and the same deep-purple narrow median line.

The specimen from off Jolo is young, with 12 arms.

The specimen from the Bay of Amboina has 24 arms 35 mm. long. The four IIIBr series present are all externally developed; one of the postradial series bears two, and two of the others bear one each. The cirri have 27 segments and are 14 mm. long.

The specimen from the Danish Expedition to the Kei Islands station 24 has about 30 arms and resembles that following.

In the specimen from the Danish Expedition to the Kei Islands station 54 the cirri are XXIII, 29–31, 20 mm. long. The first segment is very short, the second is twice as broad as long, the third is slightly longer than broad, and the fifth–seventh or –eighth are the longest, twice as long as broad. The segments following decrease in length so that the outer are slightly broader than long. The tenth and following segments bear long sharp dorsal spines which are directed obliquely forward. The 27 arms are 55 mm. long. Of the seven IIIBr series present, 6 are externally developed and one is internal, by the side of an internal series. The lateral edges of the elements of the division series are rather broadly flattened. The lateral borders of the dorsal surface of the elements of the division series are thickly beset with short papillae or short spines. Along the articulations between the axillaries and the ossicles preceding this ornamentation runs inward half way to the median line in the form of a broad triangle. The distal border of the radials is finely beaded, and the dorsal surface carries a few well spaced low tubercles. The ossicles of the division series and the brachials have a prominent but low and narrow rounded median keel that becomes less conspicuous after the proximal third of the arms but is traceable to the arm tips.

P_1 is 5 mm. long, with 18 segments. The first four segments are broad, but beyond the fifth the pinnule is slender and flagellate. The first segment is slightly broader than long, the second is also slightly broader than long, and the third is about as long as broad. The fourth tapers distally and is longer than the width of the proximal end. The fifth and following segments are twice as long as broad or somewhat longer. The second–fourth segments have a narrow knifelike keel that disappears at the distal end of the latter. P_2 is 7 mm. long, with 20 segments. It is stiffer than P_1, tapers more gradually, and is composed of proportionately longer segments. The second–fourth segments are narrowly but conspicuously carinate. P_3 is 10 mm. long, with 18 segments, and is stouter than P_2. The first segment is about as long as broad, the second is slightly broader than long, the third is about one-third again as long as broad, and the fifth and following are four or five times as long as broad. The second and third segments, and the basal portion of the fourth, are carinate. P_4 is 7.5 mm. long, with 15 segments. It is more slender than P_3 and tapers more rapidly. The first two segments are slightly broader than long, the third is one-third again as long as broad, the fifth is twice as long as broad, and those following are three times as long as broad, becoming longer distally. The second and third segments are carinate. P_5 is 4 mm. long, small, weak, and flexible, with 13 segments, of which the first–third are carinate. The color is white proximally, shading into deep purple beyond the proximal third of the arms. The division series and arms have a narrow median deep purple line that coincides with the narrow carination.

A much broken specimen with 28 arms from *Siboga* station 49*a* appears to belong to this species.

The specimen dredged by the *Investigator* off Great West Torres Island was originally described as a new species under the name of *Mariametra margaritifera*. The centrodorsal is rather small and discoidal.

The cirri are XXI, 30–34, 15 mm. long. The outer segments bear long dorsal spines. The radials are short, about six times as broad as long, and are gently convex proximally and correspondingly concave distally. The IBr_1 are short, oblong, somewhat over four times as broad as long, and are in lateral apposition and slightly flattened. The IBr_2 (axillaries) are short, almost or quite triangular, two and one-half or three times as broad as long, and in lateral apposition. The radials and the portion of the centrodorsal above the proximal row of cirrus sockets are evenly and thickly covered with high small tubercles resembling those on the dorsal pole of the centrodorsal, this tubercular modification of the dorsal surface of the segments extending distally in the interradial angles, occupying the lateral third of the IBr_1 and IBr_2 and the IIBr series, thence diminishing in width and disappearing on the second brachial. The inner borders of the IIBr series are similarly modified. The IBr series have a low and narrow, but prominent, tubercular keel or row of tubercles. This is much less marked, or altogether absent, on the IIBr series and first two brachials, though it is sometimes traceable to the lowest of the triangular brachials. The elements of the IBr and IIBr series and the proximal oblong brachials have prominently everted dentate proximal and distal ends; as the brachials become wedge-shaped and triangular the everted dentate ends become gradually lower, transforming into a rather prominent finely spinous overlap that slowly dies away distally. The 18 arms are apparently 30–35 mm. long. The proportions of the brachials are the same as in *M. subcarinata*.

P_1 is 4 mm. long, moderately stout basally but tapering rather rapidly in the proximal half and becoming slender distally, with 12 segments, of which the first three are about as long as broad and those following increase in length and become three or four times as long as broad distally. P_2 is 6 mm. long, slender, but stouter than P_1 and somewhat stiffened, with about 16 segments, which at first are about as long as broad but become three or four times as long as broad distally. P_3 is similar to P_2 and of about the same size. The pinnules immediately following are small and weak, about 3 mm. long. The distal pinnules are delicate, and about 5 mm. long.

The color in alcohol is white, the division series and arms with a narrow median dorsal line of deep purple.

Localities.—Macclesfield Bank; 55–73 meters [Bell, 1894; A. H. Clark, 1908, 1912, 1913, 1918; Hartlaub, 1912] (1, B. M.).

Macclesfield Bank; 91 meters [Bell, 1894; A. H. Clark, 1912, 1913, 1918] (1, B. M.).

Dr. Th. Mortensen's Pacific expedition, 1914–1916; off Jolo (Sulu); about 36–55 meters; sand and coral; March 19, 1914 (1).

Danish expedition to the Kei Islands; Dr. Th. Mortensen; Bay of Amboina; about 91 meters; stones and sand; February 21, 1922 (1).

Danish expedition to the Kei Islands; Dr. Th. Mortensen; station 24; 100 meters; hard bottom; April 15, 1922 (1).

Danish expedition to the Kei Islands; Dr. Th. Mortensen; station 54; 85 meters; sand and coral; May 9, 1922 (1).

Siboga station 49*a*; Sapeh Strait, between Sumbava and Komodo (lat. 8°23′30″ S., long. 119°04′36″ E.); 69 meters; coral and shells; April 14, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Investigator; two miles off Great West Torres Island, Mergui Archipelgago [A. H. Clark, 1909, 1912] (1, I. M.).

Geographical range.—From the Macclesfield Bank southward to Amboina, the Kei Islands, and Sapeh Strait, between Sumbava and Komodo, and westward to the Mergui Archipelago.

Bathymetrical range.—From 55 (?36) to 100 meters; the average of 7 records is 73 meters.

History.—*Antedon vicaria* was described by Prof. F. Jeffrey Bell in 1894 from a much broken specimen from the Macclesfield Bank. He described it as a member of Carpenter's *Spinifera* group of *Antedon* (which included the species of the families Thalassometridae and Charitometridae with the IIBr series 2), and compared it only with *Ptilometra macronema.* At the same time he recorded another specimen from the Macclesfield Bank under the name of *Antedon ?variispina.*

In 1908 I wrote that *Antedon vicaria* is not identifiable from the published description. Although described in the *Spinifera* group, it is in reality a member of the *Palmata* group.

In 1909 I described *Mariametra margaritifera* from a single broken specimen that had been dredged by the *Investigator* off Great West Torres Island in the Mergui Archipelago.

In my memoir on the crinoids of the Indian Ocean published in 1912, I redescribed and figured *Mariametra margaritifera,* and under the heading *Mariametra vicaria* redescribed the type specimen of Bell's *Antedon vicaria* and Bell's second specimen from Macclesfield Bank. I said that in the original description this species was referred to Carpenter's *Spinifera* group and compared with *Ptilometra macronema,* with which it has not the remotest relation.

In discussing Carpenter's *Spinifera* group in 1912, Dr. Clemens Hartlaub said that the description of *Antedon vicaria* is very deficient, and in the absence of a figure we can form no correct opinion in regard to the species.

In 1913 in a paper on the crinoids of the British Museum, under the name of *Mariametra vicaria* I redescribed the type specimen of Bell's *Antedon vicaria* and also described a second specimen that I had found in the collection labeled *Antedon ?variispina*.

In my memoir on the unstalked crinoids of the *Siboga* expedition published in 1918, I recorded and gave notes on a specimen of *Mariametra vicaria* from station 49*a*. In the key to the species of *Mariametra* I included *vicaria*, with a footnote giving *M. margaritifera* A. H. Clark as a synonym.

MARIAMETRA DELICATISSIMA (A. H. Clark)

Plate 61, Figures 279, 280

[See also vol. 1, pt. 1, fig. 17 (disk), p. 67.]

Antedon delicatissima A. H. Clark, Proc. U. S. Nat. Mus., vol. 33, 1907, p. 131 (color), p. 149 (description; *Albatross* station 4930).

Himerometra delicatissima A. H. Clark, Smithsonian Misc. Coll., vol. 50, 1907, p. 356 (listed); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 317 (Japan).

Dichrometra delicatissima A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 149 (synonymy; locality).

Mariametra delicatissima A. H. Clark, Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 33 (compared with *M. tuberculata*); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Journ. Washington Acad. Sci., vol. 5, 1915, p. 214 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga* Exped., 1918, p. 108 (in key: range).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol 45, No. 11, 1934, p. 25.

Diagnostic features.—The arms are about 30 in number, 70 mm. long; beyond the second brachial they bear a narrow interrupted dark stripe that extends nearly their entire length; the cirri, which are nearly half as long as the arms, have 40 segments of which the longest earlier are much elongated and the distal are simply carinate dorsally; P_3 is much the longest pinnule, 11 mm. long with about 20 elongated cylindrical segments.

Description.—The centrodorsal is low hemispherical, with a large bare polar area. The cirri are marginal.

The cirri are about XXX, 40, 30 mm. long. The earlier segments are much elongated and the distal are short; none of them bear dorsal spines.

The radials are concealed. The IBr_1 are short and are in lateral contact in the basal half. The IBr_2 (axillaries) are low pentagonal and are well separated laterally. The IIBr and IIIBr series are 2, the latter being developed only externally. They resemble the IBr series but are proportionately longer. The lateral ornamentation of the division series is reduced to a slight and very inconspicuous roughening of the sides of the ossicles, the dorsal surface being entirely smooth.

The 28 arms are 70 mm. long. The first 10 brachials are oblong, and those following are short wedge-shaped, becoming oblong again distally.

Syzygies occur between brachials 3+4 (sometimes between brachials 2+3), again from between brachials 15+16 to between brachials 21+22, and distally at intervals of from 4 to 6 muscular articulations.

P_1 is short, 5 mm. in length, and is composed of 15 short segments. P_2 is longer than P_1. P_3 is much the longest pinnule, 11 mm. long, with about 20 elongated cylindrical segments. The pinnules following are short, becoming longer again and slender distally.

Beyond the second brachial the arms bear a narrow interrupted dark purple dorsal stripe that extends nearly their entire length.

Locality.—*Albatross* station 4930; in Colnett or Vincennes Strait; northeastern point of Yaku Shima bearing N. 19° W., 10.7 miles distant (lat. 30°12′00″ N., long. 130°44′00″ E.); 153 meters; broken shells, coral, and pebbles; bottom temperature 23.78° C.; August 15, 1906 [A. H. Clark, 1907, 1908, 1912, 1913, 1915, 1918] (1, U.S.N.M., 22646).

History.—This species was described by me as *Antedon delicatissima* on September 17, 1907, from a specimen dredged by the *Albatross* in 1906 at station 4930.

In my first revision of the old genus *Antedon*, published on October 29, 1907, *delicatissima* was assigned to the new genus *Himerometra*. It was not mentioned in my revision of the family Himerometridae published in 1909.

In a paper on new crinoids belonging to the families Himerometridae, Mariametridae, and Colobometridae collected by the *Siboga* in the Dutch East Indies published in July 1912, the new species *Mariametra tuberculata* was said to be nearest *M. delicatissima*.

In my memoir on the crinoids of the Indian Ocean published on November 22, 1912, I listed *Dichrometra delicatissima* and gave the synonymy and locality.

In my memoir on the unstalked crinoids of the *Siboga* expedition published in 1918 *delicatissima* was included in the key to the species of *Mariametra*, and the range was given.

MARIAMETRA TUBERCULATA A. H. Clark

PLATE 61, FIGURE 281

[See also vol. 1, pt. 2, fig. 196 (lateral view), p. 124.]

Mariametra tuberculata A. H. CLARK, Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 33 (description; *Siboga* station 51); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 108 (in key; range; detailed description; station 51), p. 271 (listed), pl. 20, fig. 44—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 25.

Diagnostic features.—The arms are about 30 in number, 75 mm. long; there is a faint median dorsal line of pinkish on the proximal half of the arms, but none on the division series; the sides of the ossicles of the division series are coarsely tubercular; the cirri, which are about one-quarter the length of the arms, have less than 30 segments, of which the longest are twice as long as broad and the last four or five are from about as long as broad to one-third again as long as broad; the last 11 or 12 cirrus segments have a slight distal dorsal carination; P_3 is 12 mm. long, with 16–18 segments, half again as long as P_2.

Description.—The centrodorsal is large, thick discoidal, with the dorsal pole slightly convex, 2 mm. in diameter. The cirrus sockets are arranged in two closely crowded and irregular alternating rows.

The cirri are XXI, 25–27, 20 mm. long, and rather slender, with a slight distal taper. The first segment is short, the second is longer, the third is nearly as long as broad, the fourth is slightly longer than broad, and the sixth and following are twice as long as broad. The segments following the tenth slowly decrease in length so that the last four or five before the penultimate are from about as long as broad to one-third again as long as broad. The last 11 or 12 segments have a slight distal dorsal carination, which is low and rises very gradually from the dorsal surface of the segments, but ends rather abruptly distally; it is so slight that the cirri appear practically smooth. The opposing spine is moderate in size, triangular, arising from the entire dorsal surface of the penultimate segment, terminal, and directed obliquely forward. The distal ends of the cirrus segments are slightly prominent.

The radials are almost wholly concealed by the centrodorsal, being only slightly visible in the interradial angles. The IBr_1 are very short, almost oblong, five or six times as broad as long. The IBr_2 (axillaries) are very short, nearly or quite three times as broad as long. The IIBr and IIIBr series are 2, the latter externally developed. The sides of the elements of the division series are in close apposition and sharply flattened. The proximal edge of the IBr_1 is everted and slightly scalloped. The outer edges of the IBr_2 are slightly thickened and everted but smooth. The lateral third of the exposed surface of both ossicles taken together bears from a dozen to a dozen and a half prominent, well-rounded, and entirely separate tubercles, some of which may be more or less elongate in one diameter; between the tubercular lateral and smooth dorsal surface of the elements of the IBr series there is a more or less marked prominent beaded ridge or row of tubercles, which, however, may be absent. The sides of the ossicles of the IIBr series are modified in the same way as those of the ossicles of the IBr series, but not so extensively.

The arms are about 26 in number, 75 mm. long; the proximal outer angle of the first brachial is roughened for some distance inward, and sometimes more or less tuberculated. The surface of the second brachial is similarly modified but much less extensively. The synarthrial tubercles are small, but rather prominent. The distal edges of the brachials are only very slightly produced.

P_1 is 7 mm. long, with 21 segments, tapering rather rapidly in the proximal fourth, slender from that point onward, with most of the component segments about twice as long as broad. P_2 is 8 mm. long, with 17–20 segments, of which the first is nearly twice as broad as long, the second nearly as long as broad, the third one-third again as long as broad, and the remainder about twice as long as broad; the second–fifth are narrowly carinate; the pinnule is basally little, if at all, larger than P_1, but it tapers less rapidly and is slightly less slender distally. P_3 is 12 mm. long, with 16–18 segments, slightly stiffened like P_2 in *Lamprometra palmata*, tapering evenly from the base to the tip, larger and stouter than P_2, which more nearly resembles P_1; the proportions of the individual segments are as in P_2; second–fourth segments have a slight narrow carination. P_4 is similar to P_3, 9 mm. long with about 16 segments, larger, longer and stouter than P_2, and stiffened like P_3. P_5 is 4.5–5.0 mm. long, with 15 segments, small and weak, evenly tapering and becoming very slender distally. The following pinnules decrease gradually in size, then increase in length and become very slender distally.

The color in alcohol is white, with a faint median line of light pinkish in the proximal half of the arms.

Locality.—*Siboga* station 51; Molo Strait, between Flores and Rindja; 69–91 meters; fine gray sand; or coarse sand with shells and stones; April 19, 1899 [A. H. Clark, 1912, 1913, 1918] (1, Amsterdam Mus.).

History.—*Mariametra tuberculata* is as yet known only from the single specimen collected by the *Siboga*, originally described in 1912 and redescribed and figured in 1918.

MARIAMETRA TENUIPES A. H. Clark

PLATE 61, FIGURE 282

Mariametra tenuipes A. H. CLARK, Ann. Mag. Nat. Hist., ser. 8, vol. 10, 1912, p. 32 (description; *Siboga* station 294); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 144 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. VIII (discovery by the *Siboga* and its significance), p. 108 (in key; range), p. 110 (detailed description; station 294), p. 275 (listed), pl. 20, fig. 47.—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., vol. 45, No. 11, 1934, p. 20.

Mariametra tenuicirra A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. VIII (editorial error).

Diagnostic features.—The arms are 15 in number, about 45 mm. long; the division series and arms have a median line of dark purple; the sides of the ossicles of the division series bear irregular and closely crowded short blunt spines; the cirri, which are approximately half as long as the arms, have 24–29 segments, of which the longest are about three times as long as the median width and the last 10 or 11 are about as long as the distal width or very slightly longer; the eleventh and following segments have slight subterminal dorsal spines; P_3 is 11 mm. long, with 21 segments, and is less than half again as long as P_2.

Description.—The dorsal pole of the centrodorsal is slightly convex, 1 mm. in diameter, and is covered with small tubercles.

The cirri are XXVI, 24–29, 22 mm. long. The first segment is short, the second is about twice as broad as the median length, the third varies from slightly longer than broad to half again as long as broad, and the sixth–eighth are about three times as long as the median width. The segments following gradually decrease in length so that the last 10 or 11 are about as long as their distal width or only very slightly longer. The cirri are exceedingly slender. The long proximal segments have slightly prominent ends. Slight subterminal dorsal spines appear on about the eleventh segment.

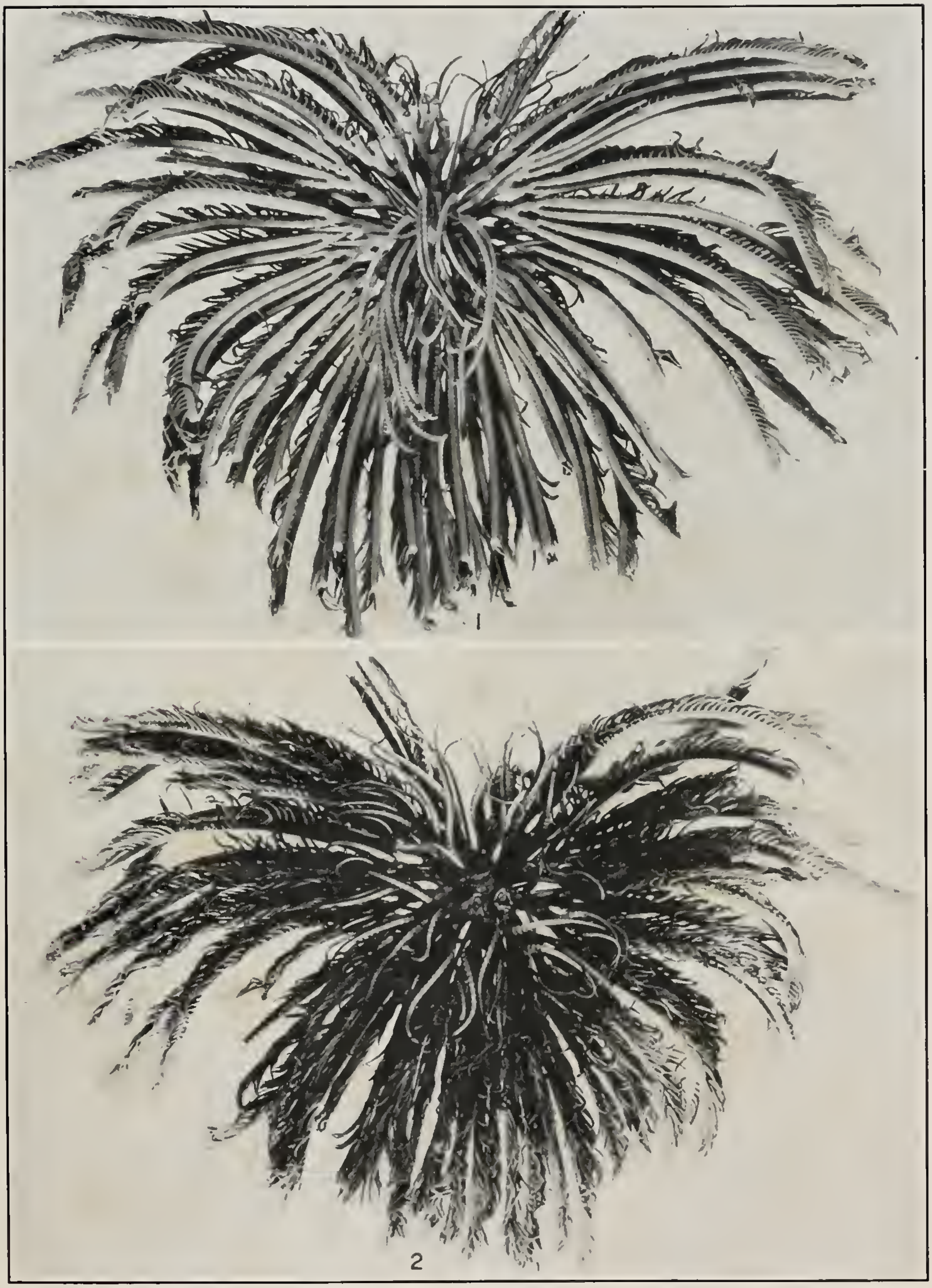
The division series and arms resemble in general those of the other species of the genus. One IIIBr series is present, externally developed. The lateral ornamentation of the division series, which occupies the outer thirds of the exposed surface of the elements of the IBr series, thence narrowing distally and disappearing at the base of P_1, consists of very numerous small blunt spines, more or less coalescent, that show a tendency to become arranged in horizontal rows.

The 15 arms are probably about 45 mm. long.

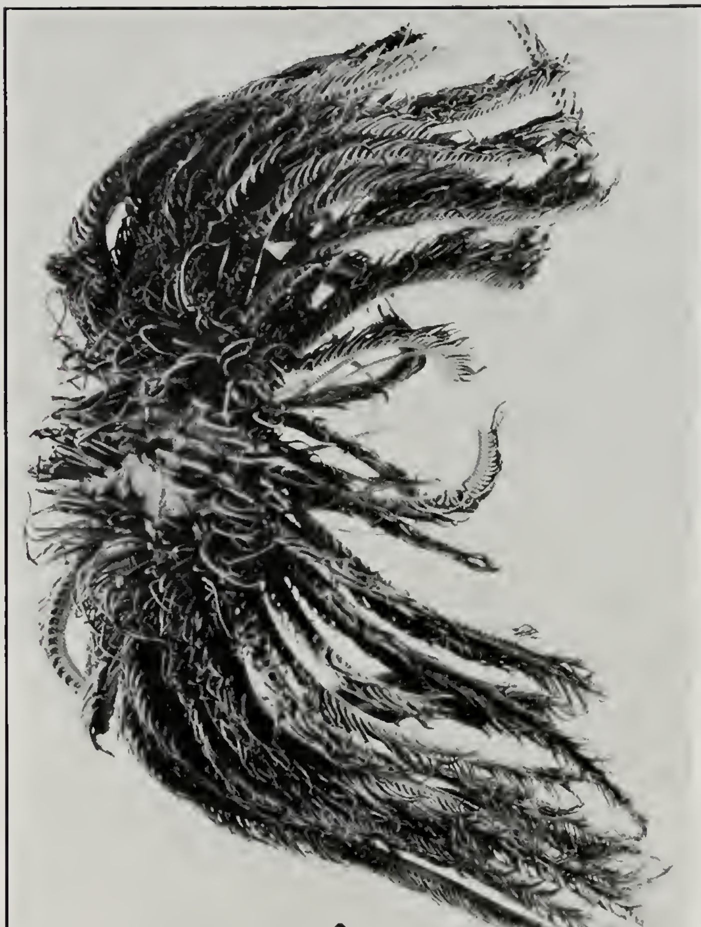
P_1 is small and short, 6 mm. long, with about 16 segments. P_2 is 7.5 mm. long, with 19 segments, resembling P_3 but not so stout, though slightly stouter than P_1. P_3 is 11 mm. long, with 21 segments, and is slender and evenly tapering. The first segment is not quite so long as broad, the second is about as long as broad, and the fifth and following are about twice as long as broad, becoming more elongated terminally. P_4 is 9 mm. long, with 19 segments, and resembles P_3.

Locality.—*Siboga* station 294; off Timor (lat. 10°12′12″ S., long. 124°27′18″ E.); 73 meters; soft mud with very fine sand; January 23, 1899 [A. H. Clark, 1912, 1913, 1918] (1, Amsterdam Mus.).

History.—*Mariametra tenuipes* was described in 1912 from a single specimen dredged by the *Siboga* at station 294; it was redescribed and figured in 1918. The type specimen still remains unique.



1, 2, *Zygometra microdiscus:* Specimen from *Siboga* station 273 (Amsterdam Mus.).



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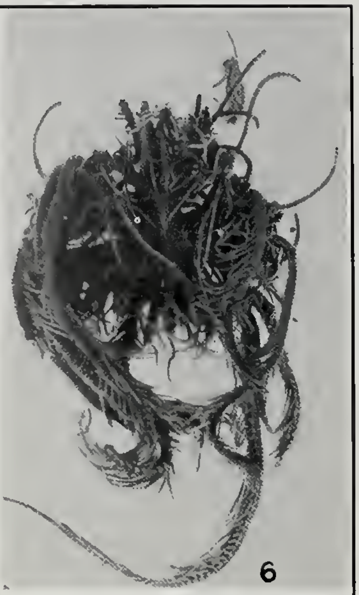

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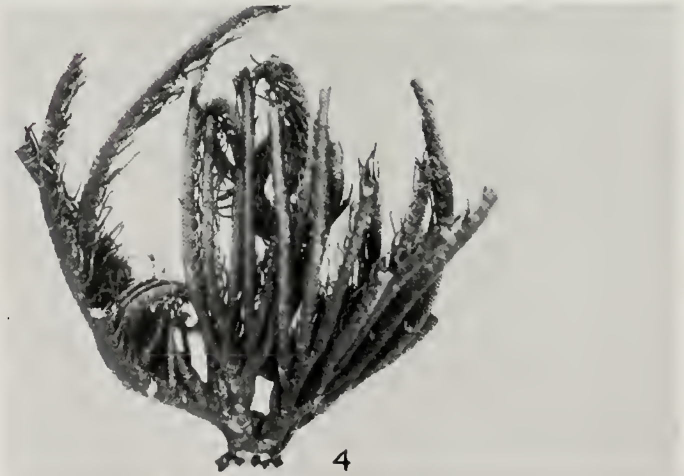

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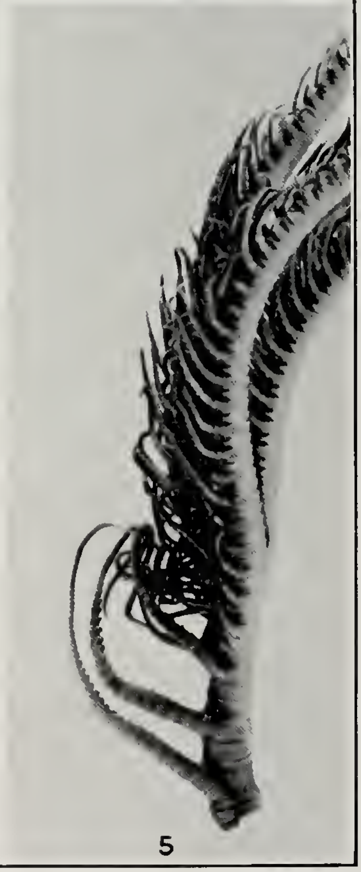

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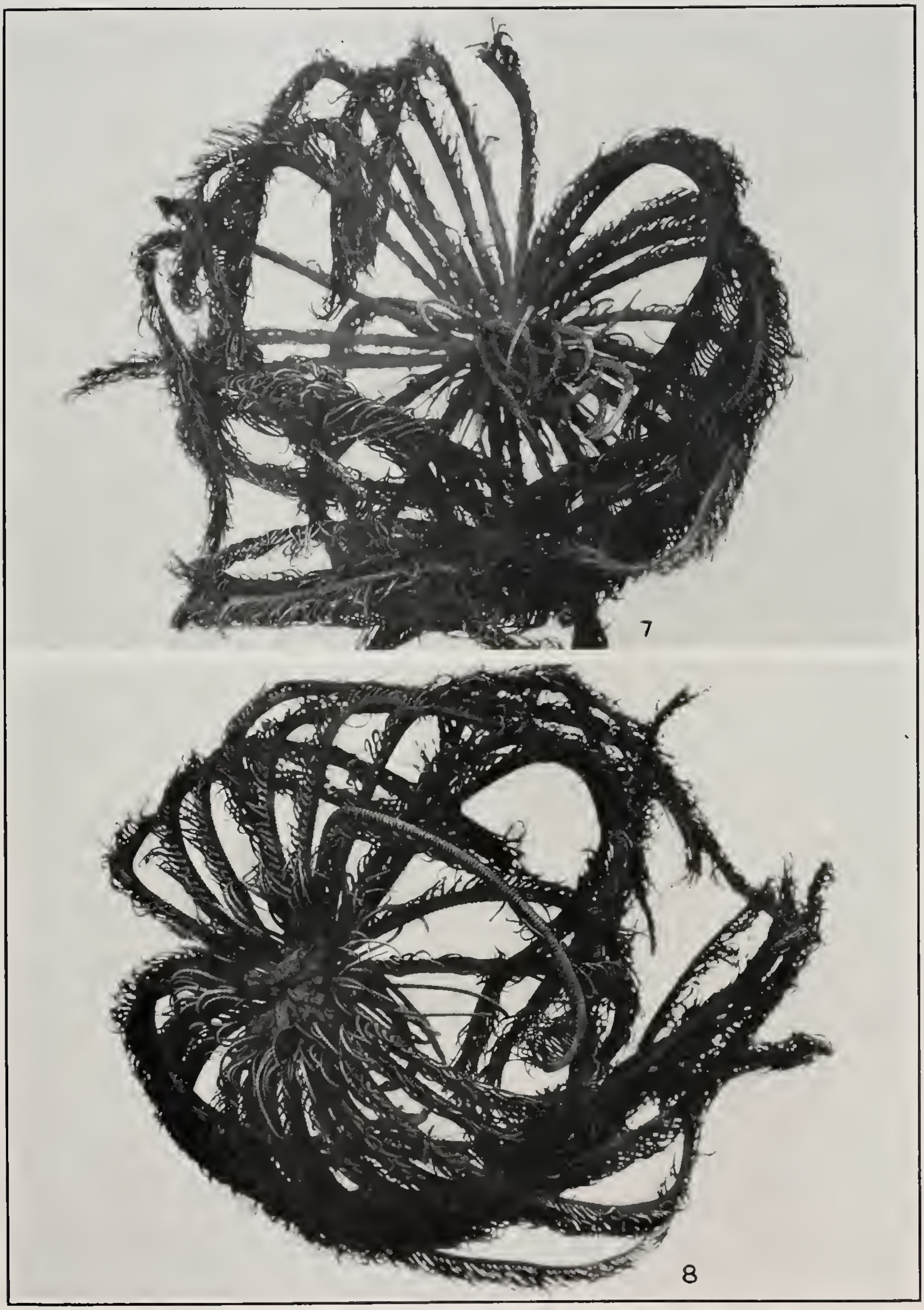
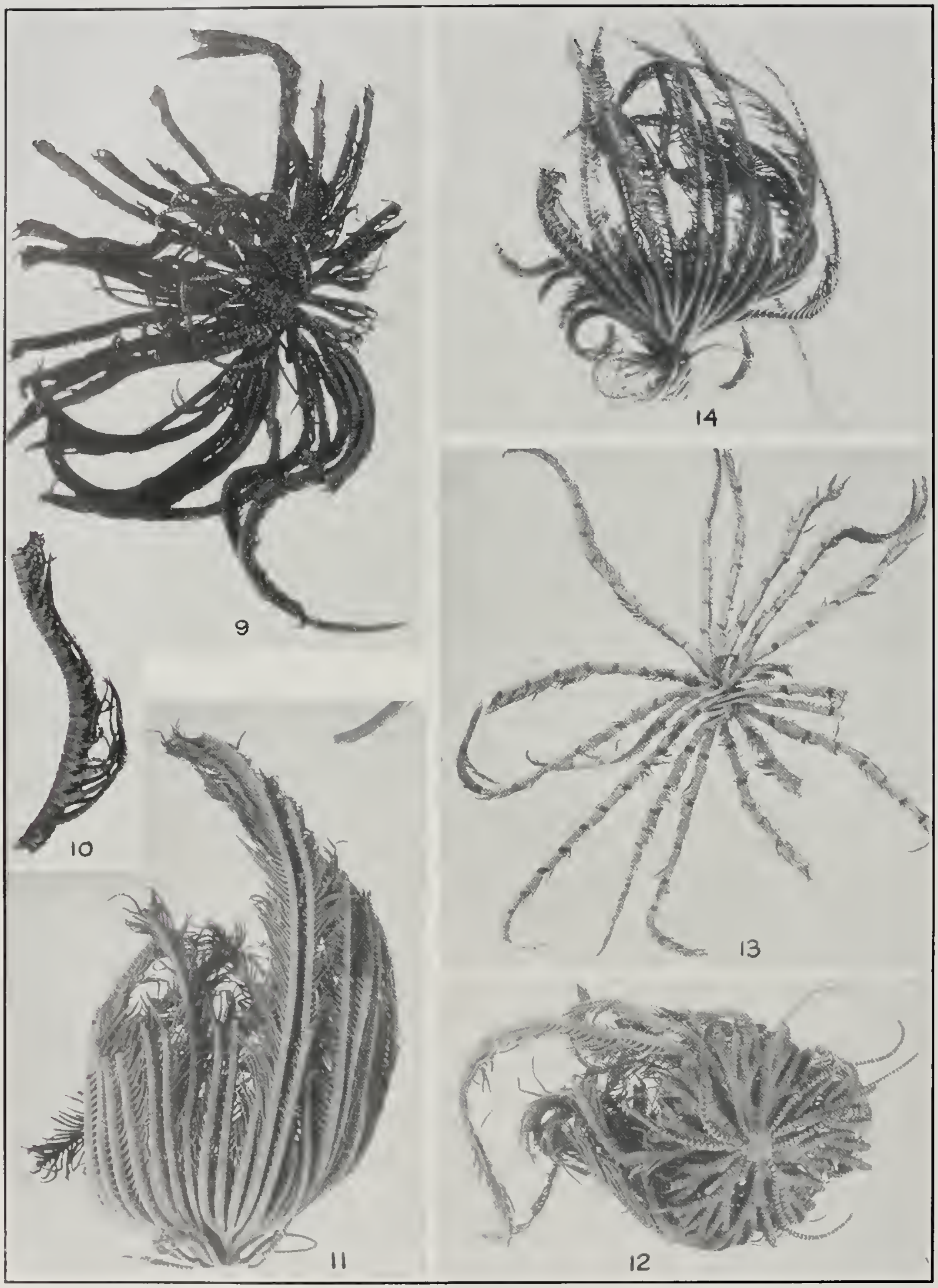
3, 4, 6, *Zygometra microdiscus:* 3, Specimen with small proximal pinnules from *Siboga* station 273 (Amsterdam Mus.); 4, dwarf, from Great Barrier Reef Expedition station XXIII, × 2 (B. M.); 6, proximal pinnules of a specimen from *Siboga* station 273, × 2 (Amsterdam Mus.).

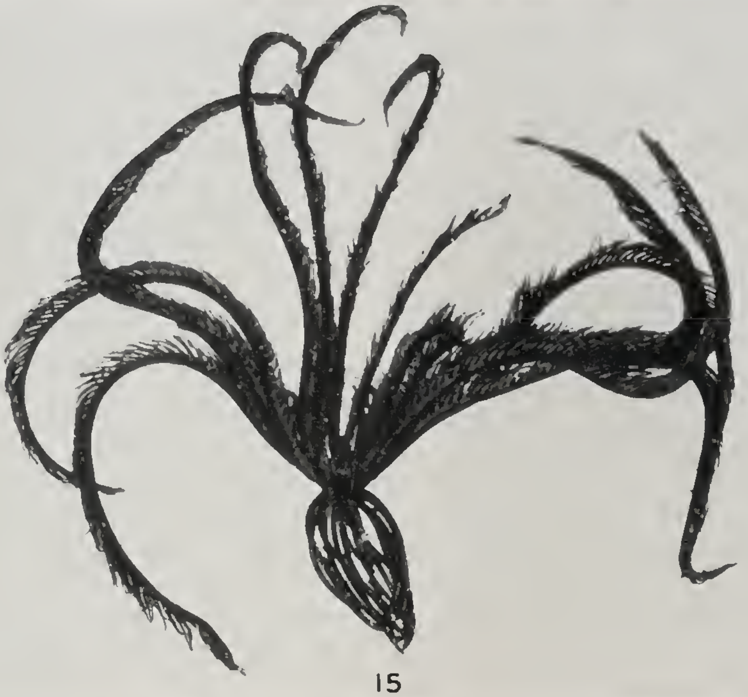
5, *Zygometra elegans* from Mermaid Strait, collected by the *Gazelle* (Berl. Mus.).



7, 8, *Zygometra elegans:* Specimen from Amboina, pier, 0–2 meters, collected by the *Willebrord Snellius* (L. M.).



9–12, *Zygometra elegans*: 9, Specimen from Port Curtis, Queensland (U.S.N.M., 35132); 10, same, proximal pinnules; 11, 12, specimen from Mermaid Strait, collected by the *Gazelle* (Berl. Mus.).
13, 14, *Zygometra comata*: 13, Specimen from Singapore (C. M.); 14, specimen from 80 miles northwest of Penang in 73 meters, collected by the *Patrol* (B. M.).



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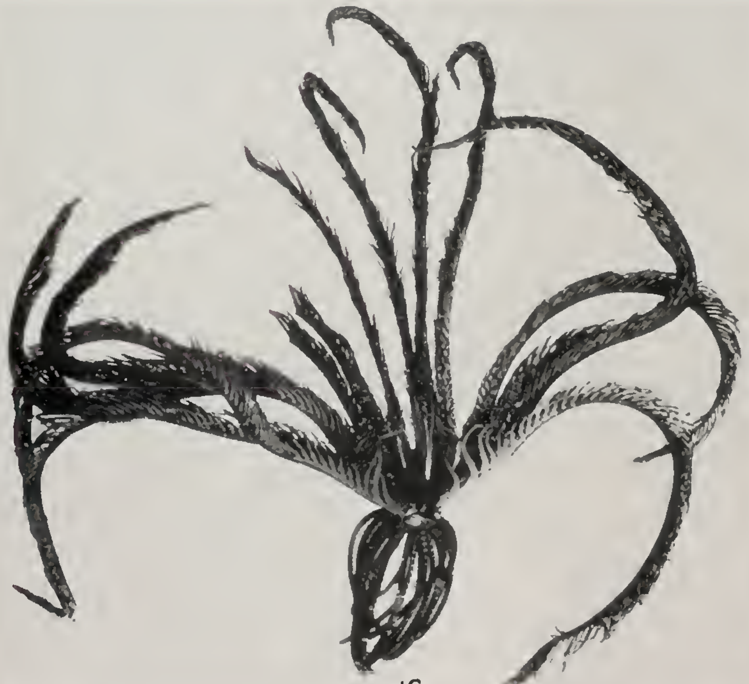

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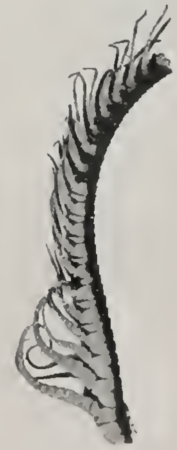

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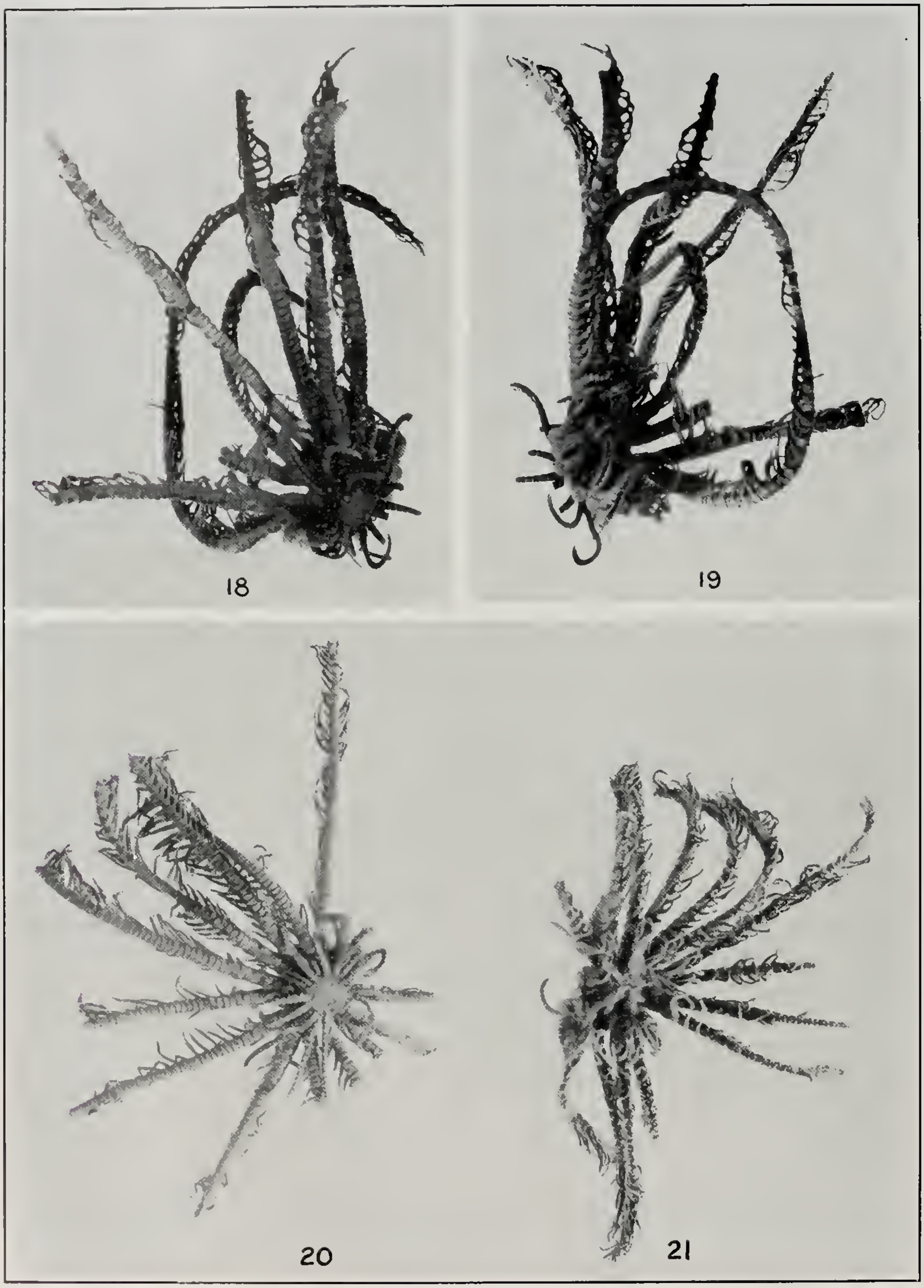
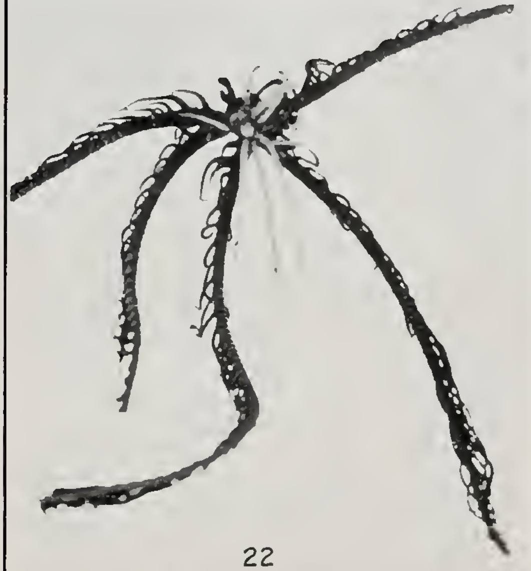
15–17, *Zygometra comata:* 15, 16, Specimen from *Albatross* station 5138 (U.S.N.M., 35137); 17, same, proximal pinnules, × 2.



18–21, *Zygometra punctata:* 18, 19, Specimen from Port Curtis, Queensland, × 2 (U.S.N.M., 35150); 20, 21, the type specimen from *Siboga* station 273, × 2 (Amsterdam Mus.).



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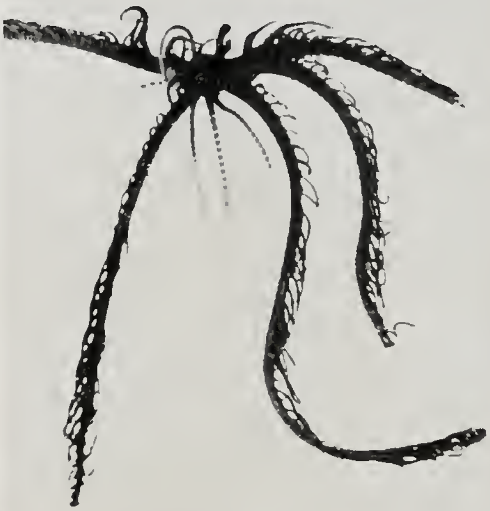

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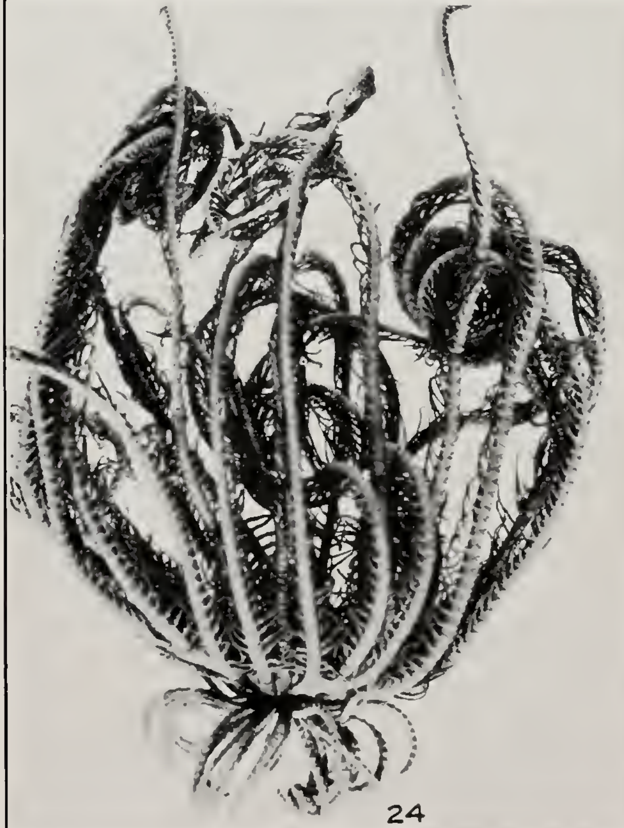

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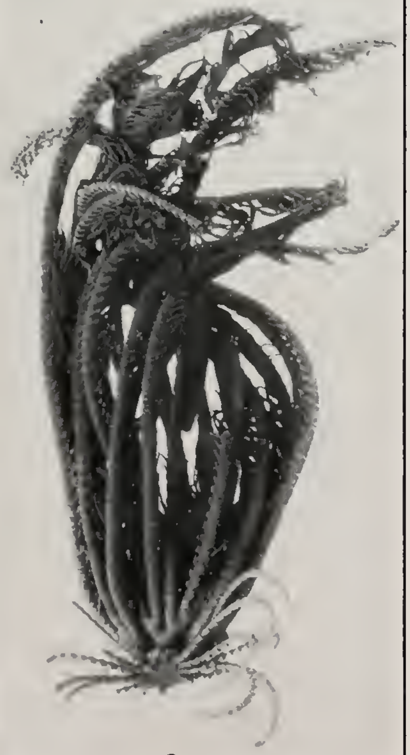

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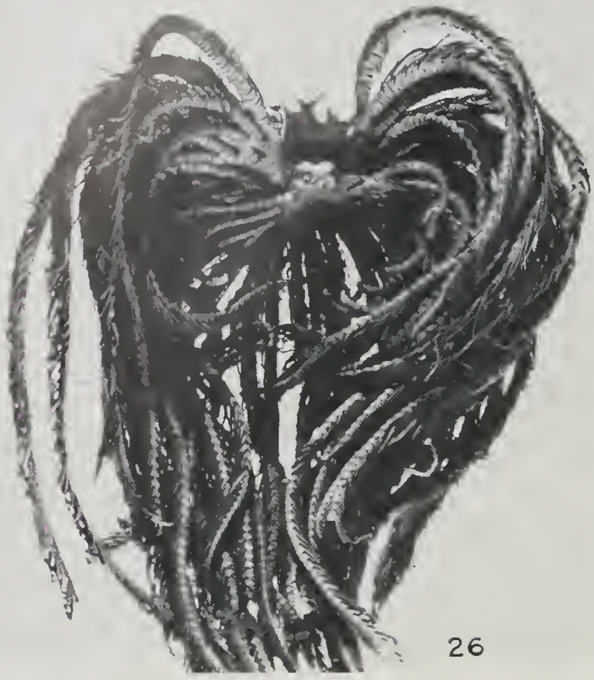
22, 23, *Zygometra pristina:* The type specimen from *Albatross* station 5276, × 2 (U.S.N.M., 27489).

24, 25, *Catoptometra magnifica:* 24, Specimen from lat. 35°15′ N., long. 128°20′ E., in 183 meters (U.S.N.M., E. 3227); 25, specimen from off Cape Padaran, southern Annam, in 146 meters, collected by the *Patrol* (B. M.).



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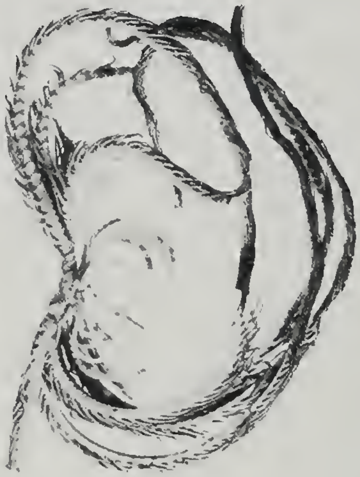

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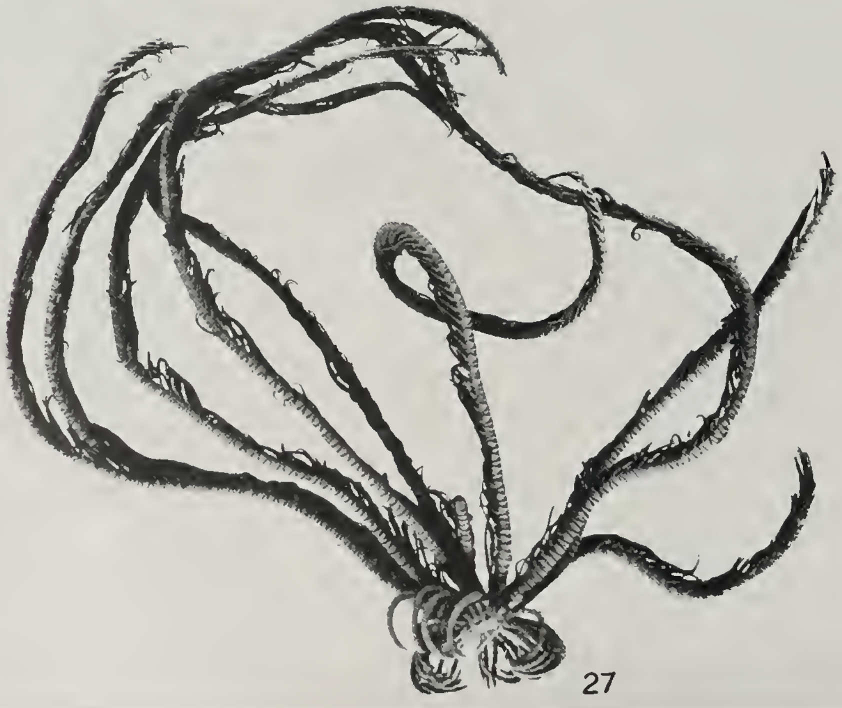

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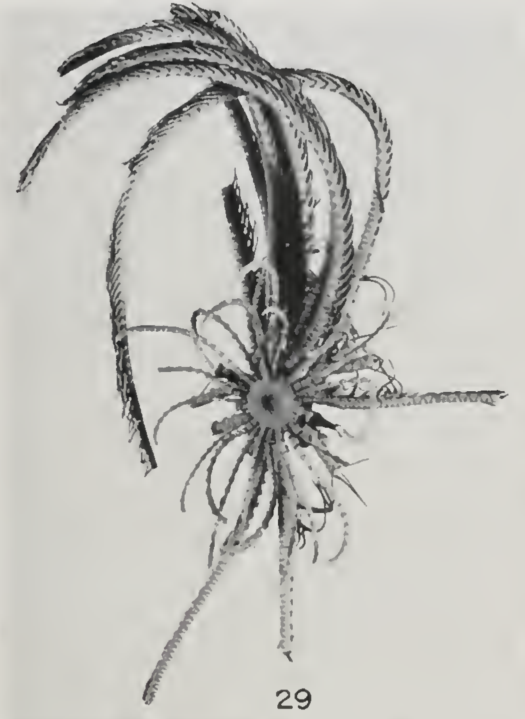
26, *Catoptometra magnifica:* The type specimen from *Albatross* station 5137 (U.S.N.M., 25436).
27, *Catoptometra rubroflava:* The type specimen from *Albatross* station 4880 (U.S.N.M., 22639).
28, *Catoptometra hartlaubi:* The type specimen from *Albatross* station 4934 (U.S.N.M., 22606).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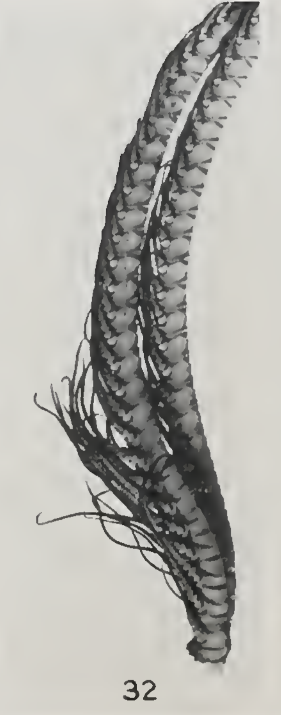
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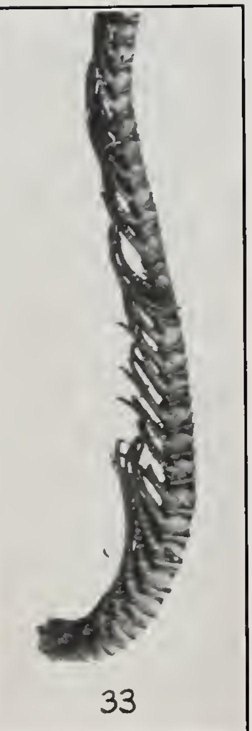
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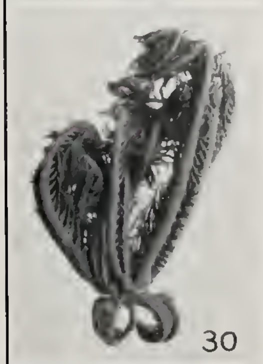
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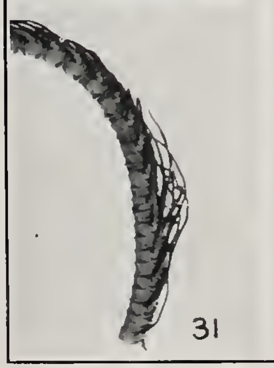
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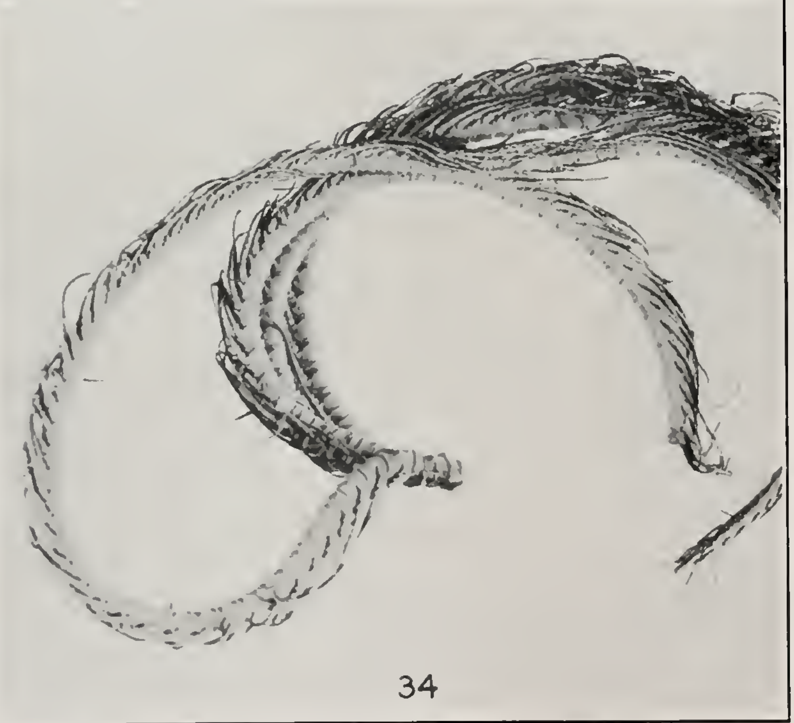
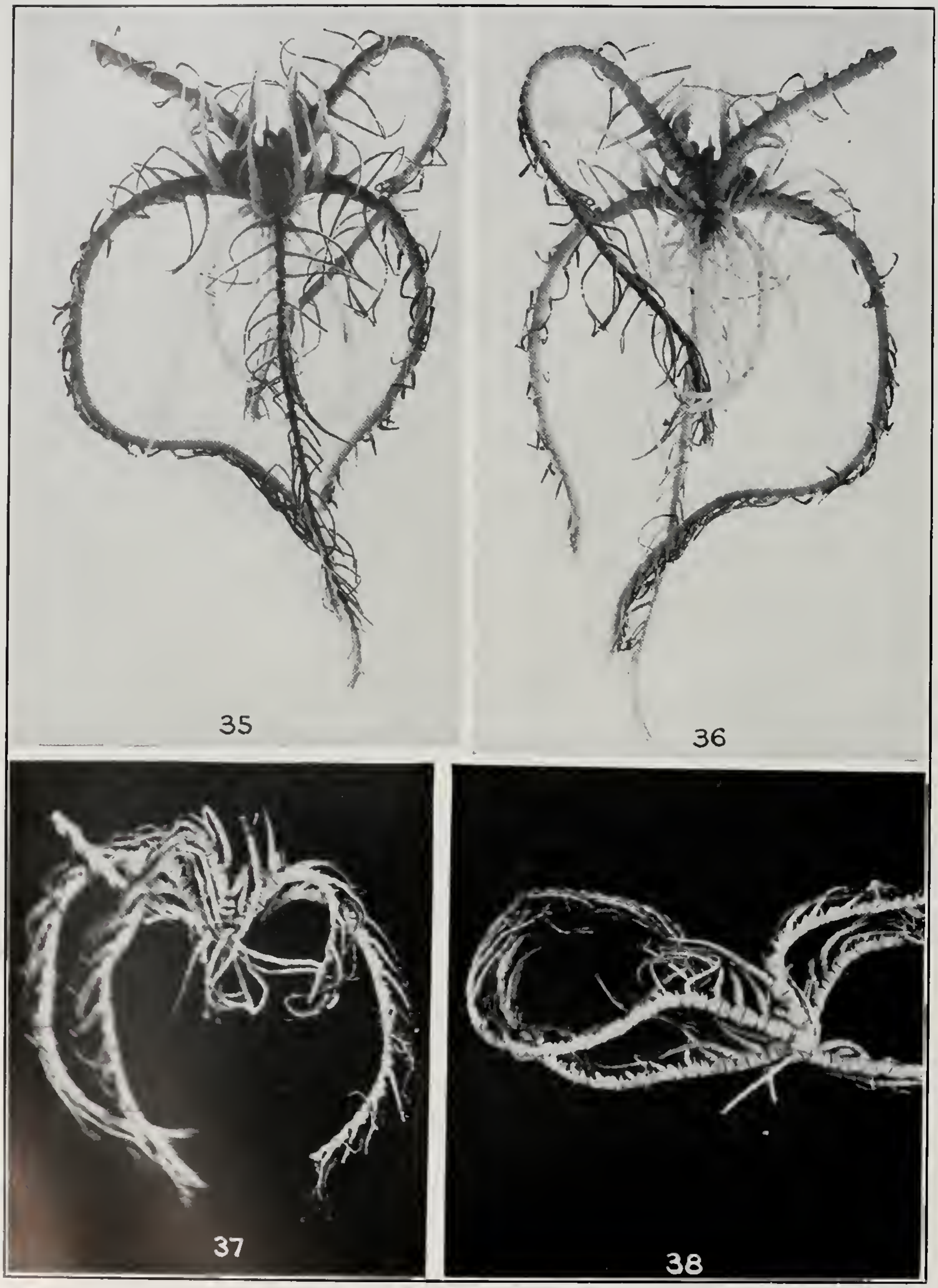

34

29, 32, *Catoptometra ophiura:* Specimen from *Albatross* station 5356 (U.S.N.M., 35131); 32, same, proximal pinnules, × 2.

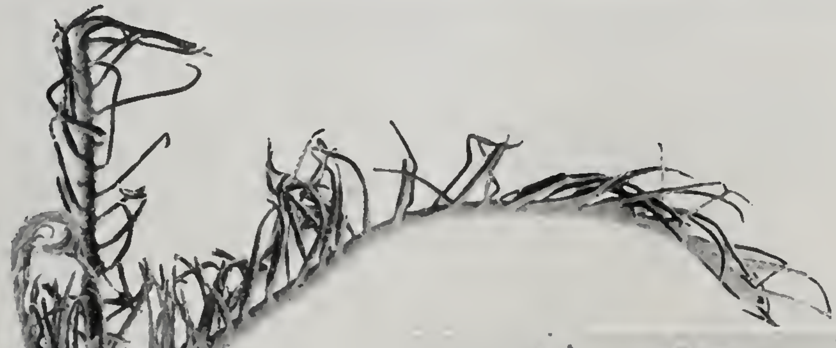
30, 33, *Catoptometra rubroflava:* 30, Specimen from lat. 33°08′ N., long. 129°20′ E., in 65 meters (C. M.); 33, proximal pinnules of the type specimen, × 2 (see fig. 27).

31, *Catoptometra magnifica:* Proximal pinnules of the type specimen, × 2 (see fig. 26).

34, *Catoptometra hartlaubi:* Proximal pinnules of the type specimen, × 2 (see fig. 28).



35, 36, *Eudiocrinus junceus:* The type specimen from *Siboga* station 167, × 2 (Amsterdam Mus.).
37, 38, *Eudiocrinus philenor:* The type specimen from *Investigator* station 534, × 3 (I. M.).



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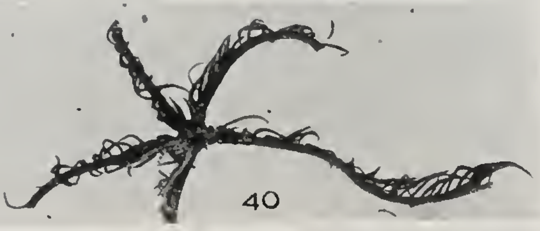

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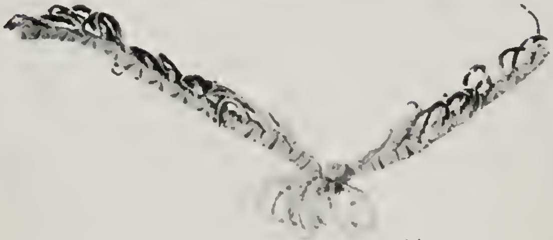

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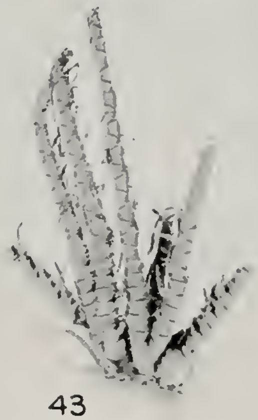

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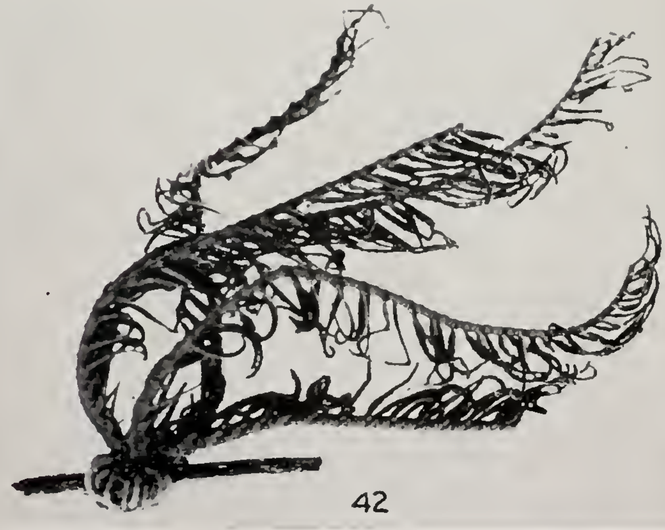

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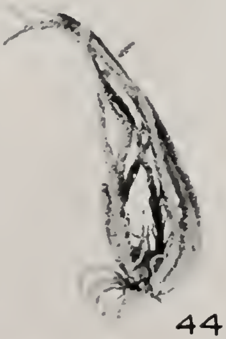


44

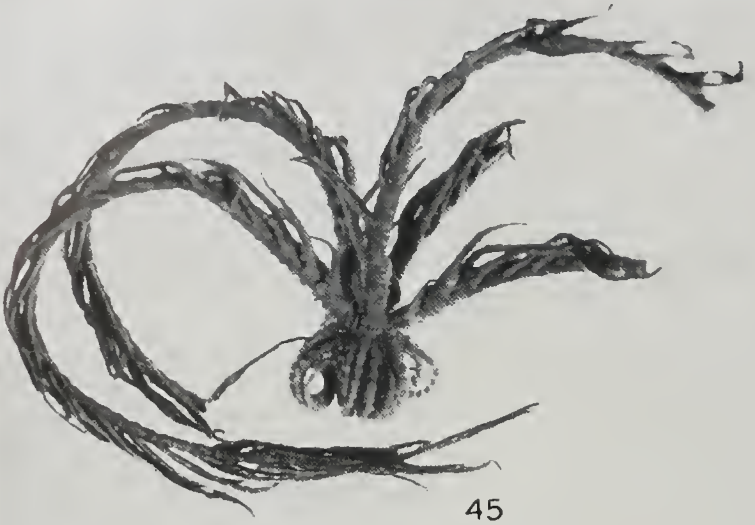
39, *Eudiocrinus pinnatus:* The type specimen from *Siboga* station 310, × 2 (Amsterdam Mus.).

40, *Eudiocrinus ornatus:* The type specimen from lat. 14°04′30″ N., long. 93°51′00″ E., in 75 meters (I. M.).

41, *Eudiocrinus variegatus:* The type specimen from Sagami Bay, Japan, in 110 meters, × 2 (U.S.N.M., 25326).

42, *Eudiocrinus indivisus:* Specimen from *Albatross* station 5356, × 2 (U.S.N.M., 35138).

43, 44, *Catoptometra hartlaubi:* 43, Young individual (type specimen of *Zygometra koehleri*) from *Albatross* station 3717, × 2 (U.S.N.M., 22660); 44, young individual from *Albatross* station 3704, × 2 (U.S.N.M., 35134).



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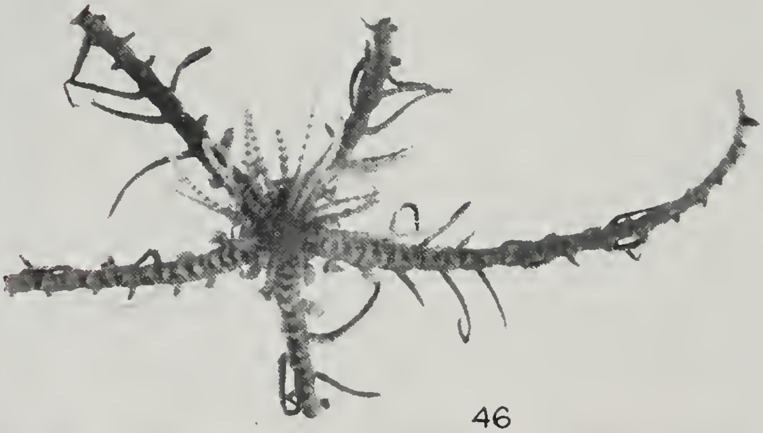

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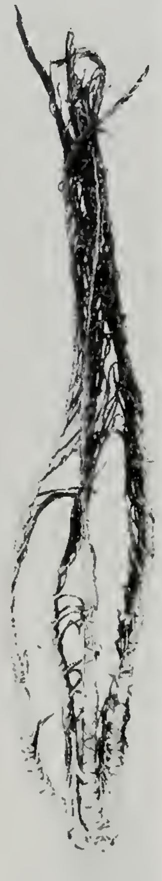

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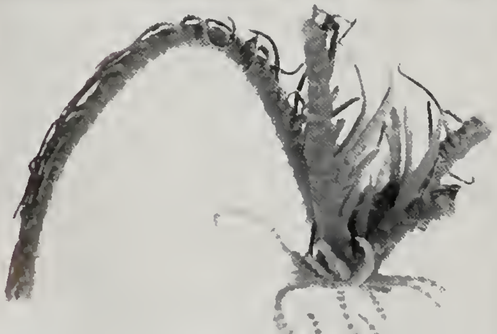

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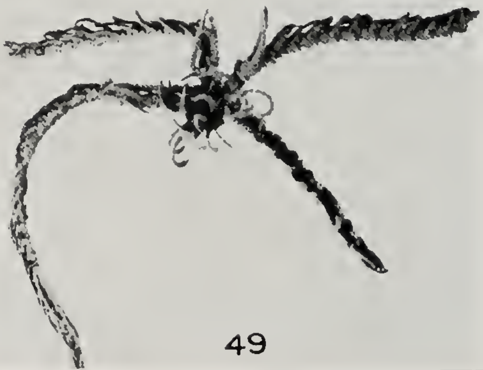

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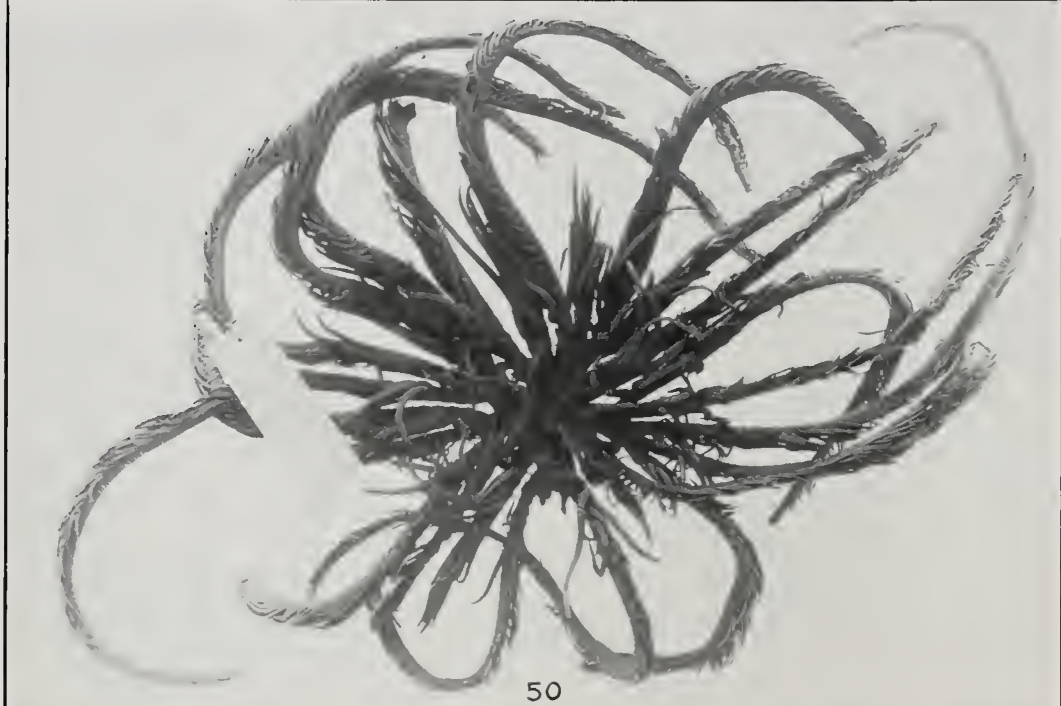
45, 46, *Eudiocrinus venustulus:* The type specimen from *Siboga* station 294, × 3 (Amsterdam Mus.).

47, *Eudiocrinus ornatus:* Specimen from *Siboga* station 294, × 2 (Amsterdam Mus.).

48, *Eudiocrinus gracilis:* Specimen from Suvadiva Atoll, Maldive Archipelago, in 80 meters or less, collected by the *Willebrord Snellius*, × 2 (L. M.).

49, *Eudiocrinus serripinna:* The type specimen from *Albatross* station 5156, × 2 (U.S.N.M., 25437).



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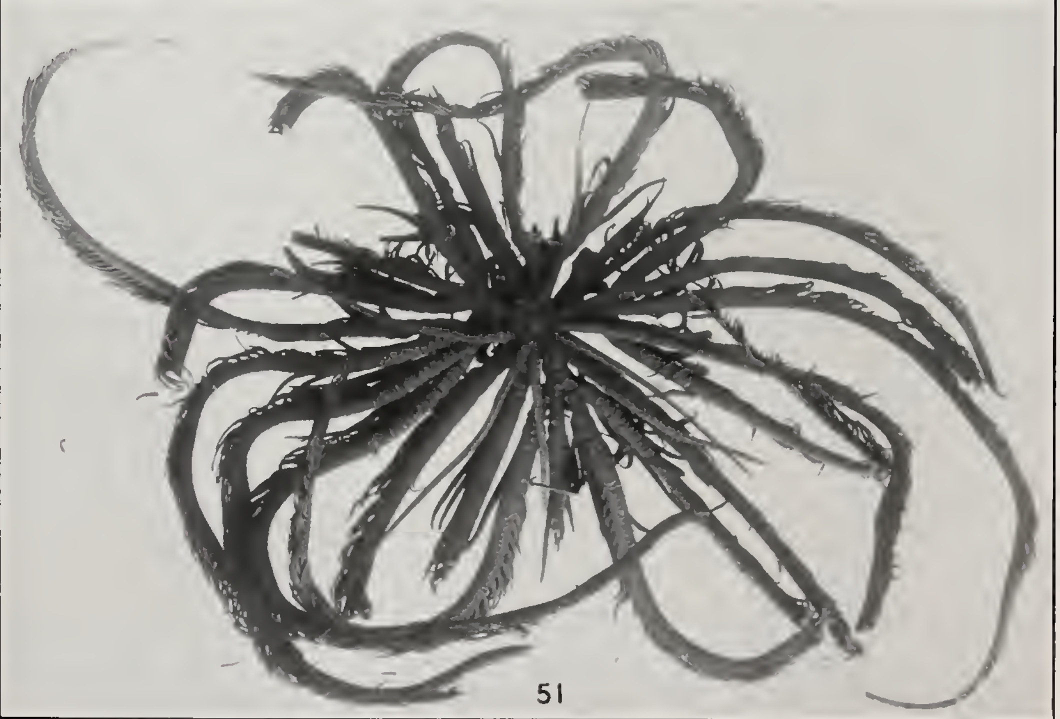

51

50, 51, *Craspedometra acuticirra:* The type specimen of *Alecto australis* (C. M.).

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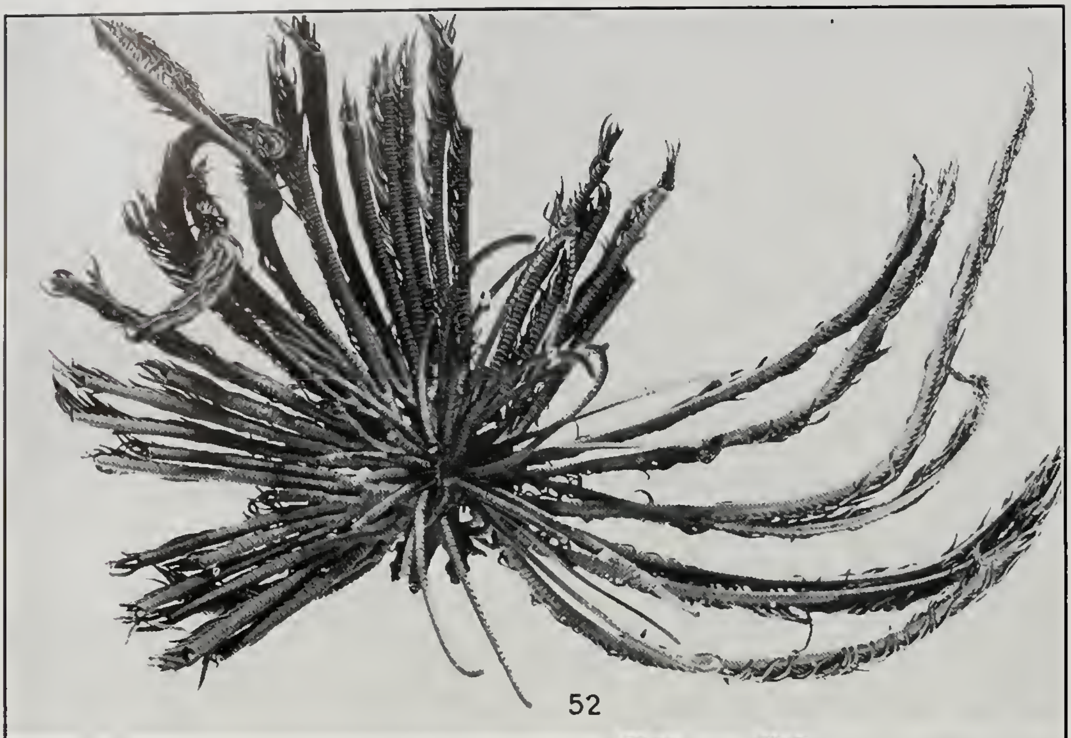

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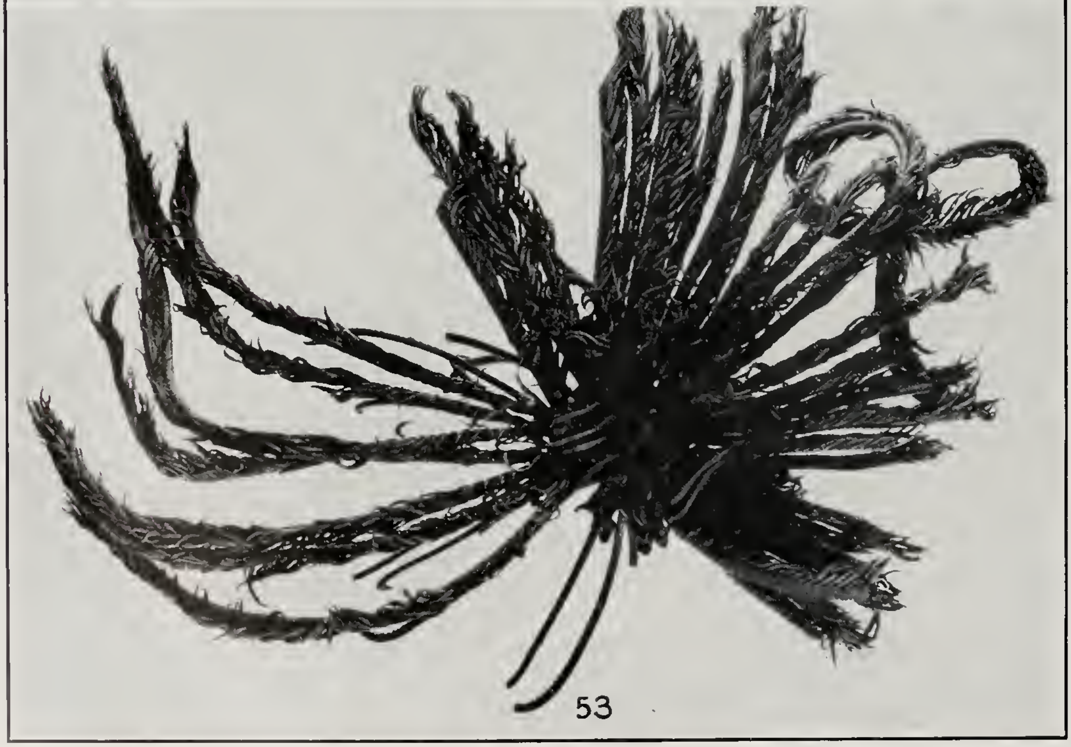

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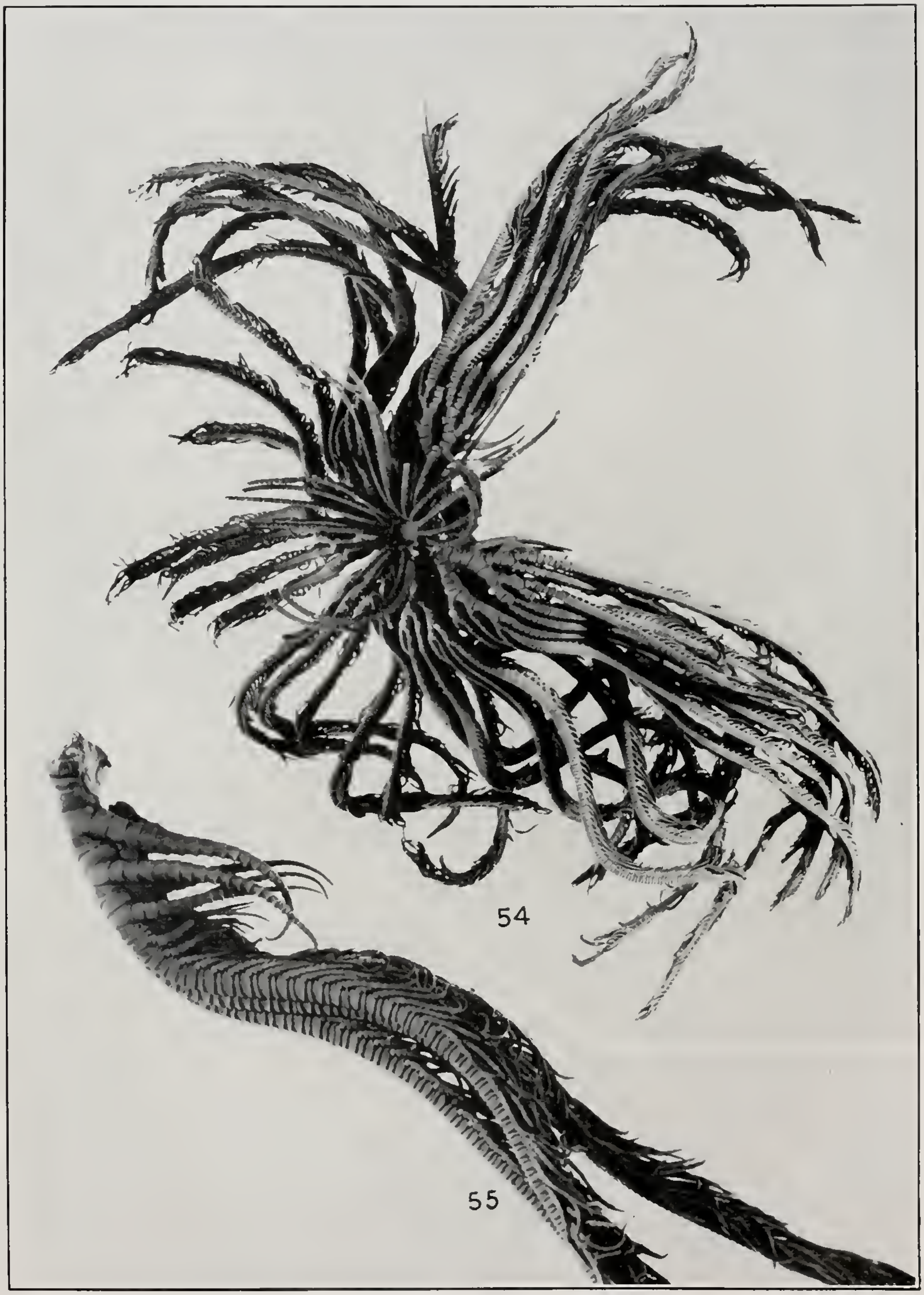
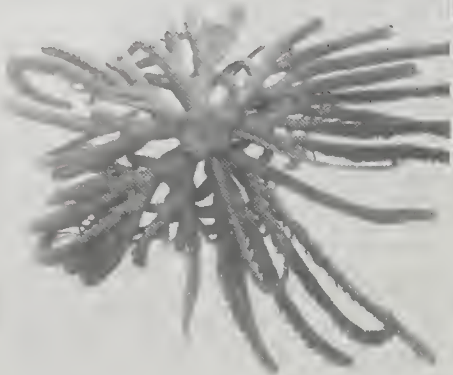
52, 53, *Himerometra bartschi:* Type specimen from *Albatross* station 5146 (U.S.N.M., 25438).



54, 55, *Himerometra magnipinna:* 54, The type specimen from *Albatross* station 5139 (U.S.N.M., 25440); 55, same, proximal pinnules, × 2.



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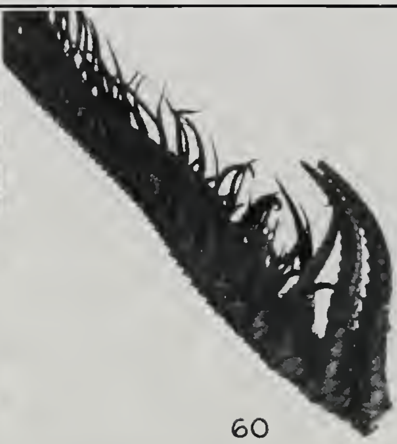

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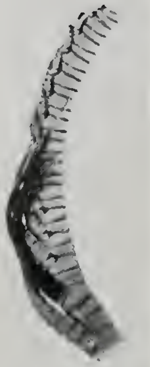

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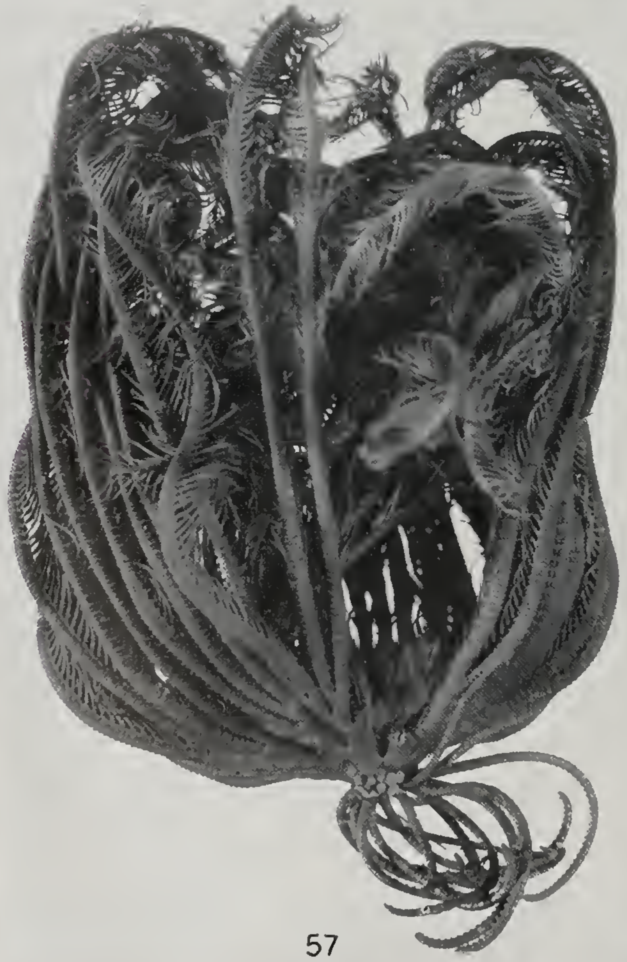

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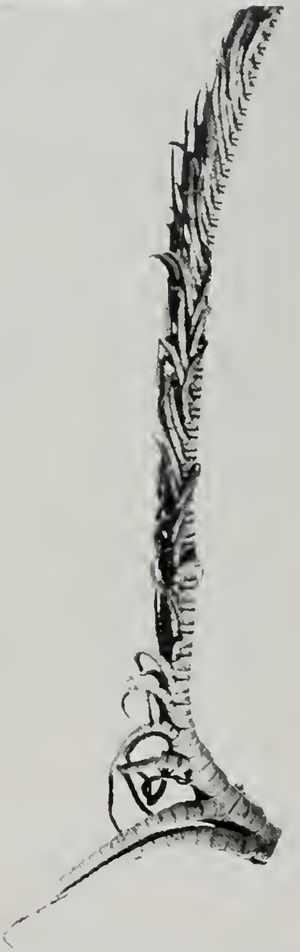

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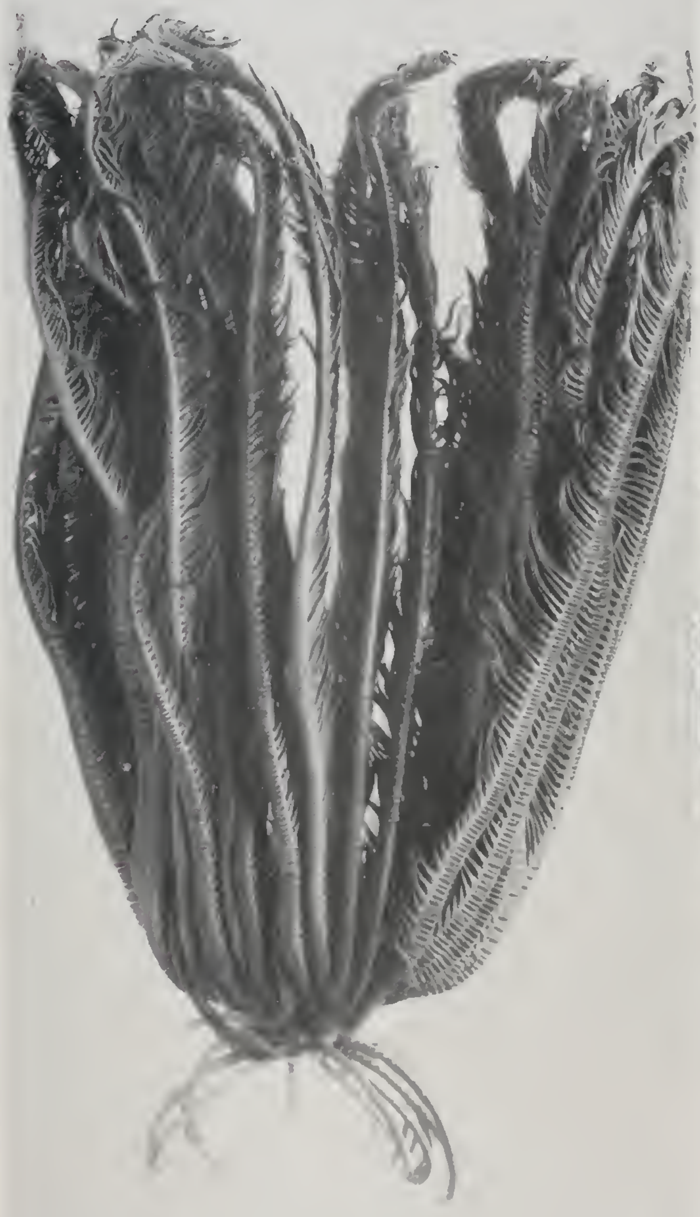
56, *Himerometra magnipinna* from Isabela, Basilan (H. M.).

57–59, *Himerometra bartschi:* 57, Specimen from Amboina, pier, 0–2 meters (L. M.); 58, proximal pinnules of type specimen, × 2 (see figs. 52, 53); 59, proximal pinnules of a specimen from *Albatross* station 5163, × 2 (U.S.N.M., 35096).

60, *Himerometra robustipinna:* Proximal pinnules of a specimen from *Albatross* station 5644, × 2 (U.S.N.M., 25971).



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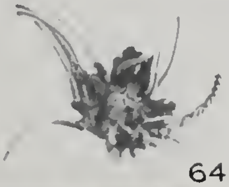

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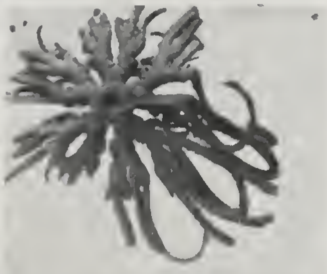

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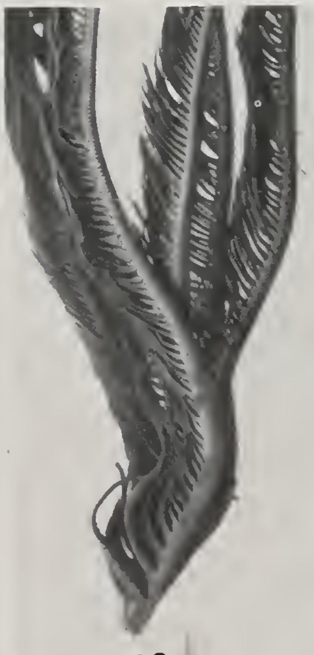

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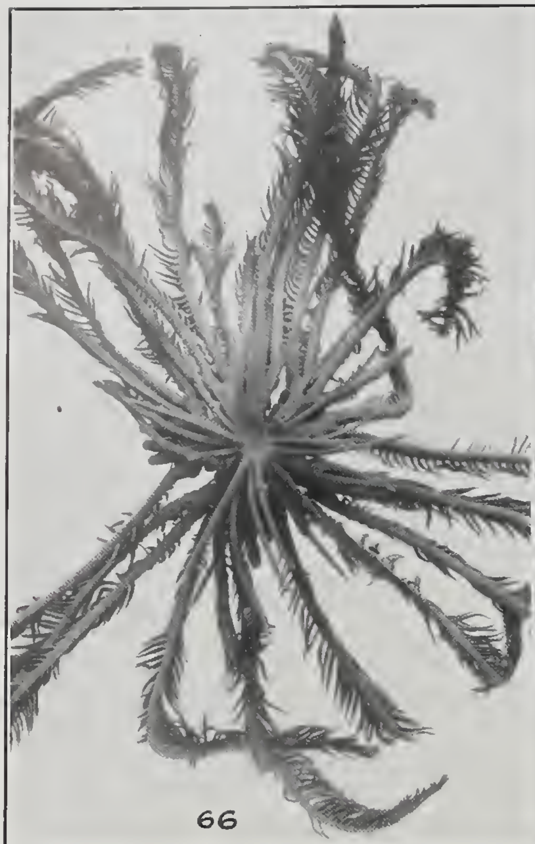
61, 62, *Himerometra magnipinna:* 61, Specimen from Cochinchina (H. M.); 62, same, proximal pinnules.
63, *Himerometra robustipinna:* Type specimen of *Antedon kraepelini* from Akyab, Burma (H. M.).
64, 65, *Himerometra martensi:* The type specimen from Singapore (Berl. Mus.).



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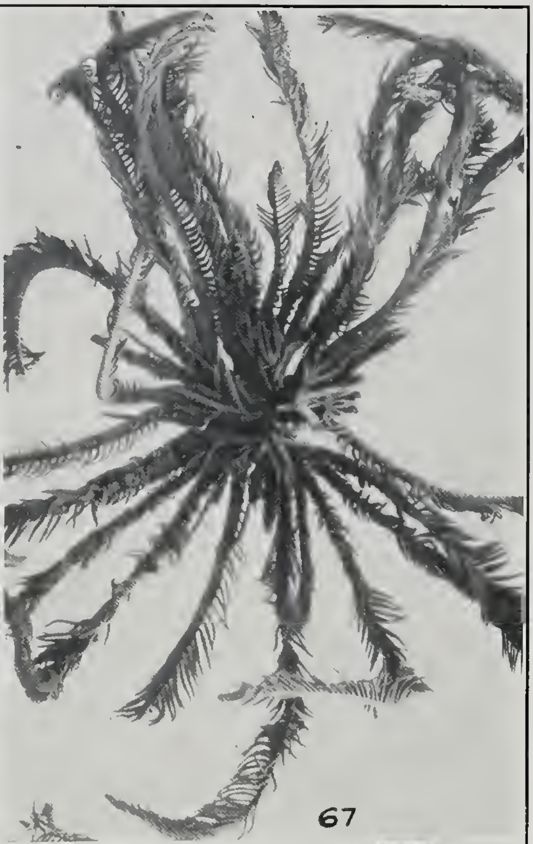

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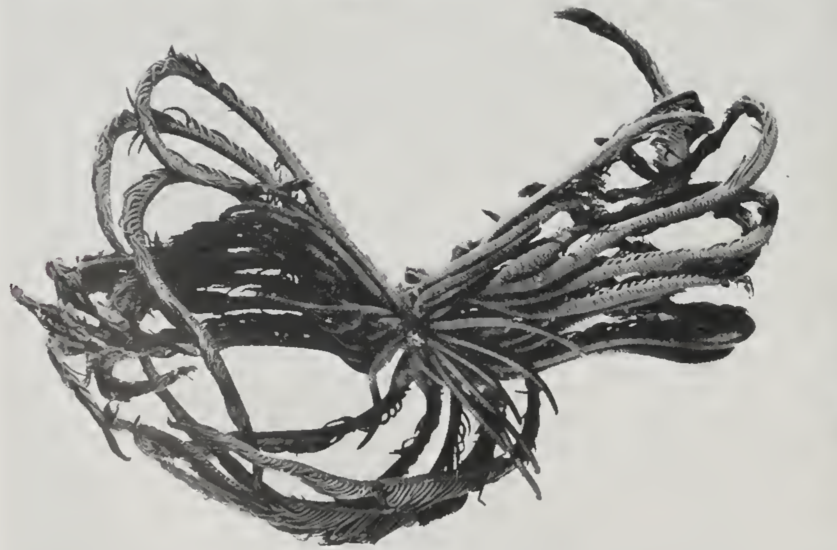

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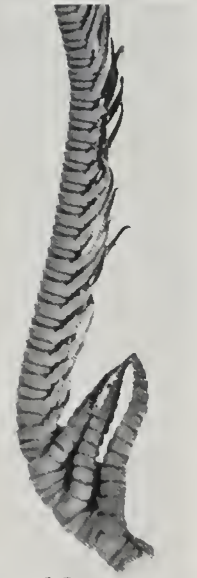

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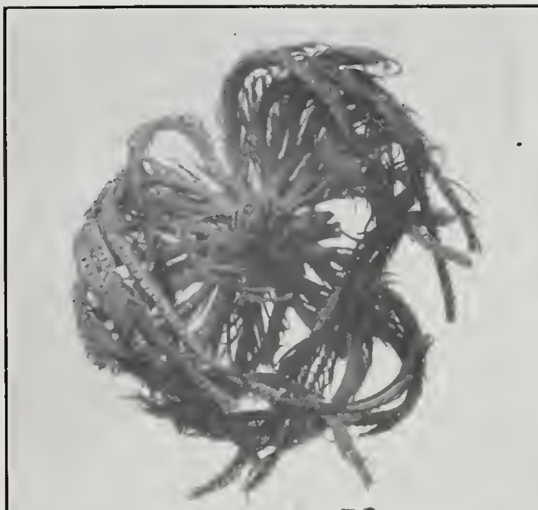
66, 67, *Himerometra martensi:* Specimen from Singapore (C. M.).
68, 69, *Himerometra robustipinna:* 68, The type specimen from *Albatross* station 5165 (U.S.N.M., 25439); 69, same, proximal pinnules, × 2.



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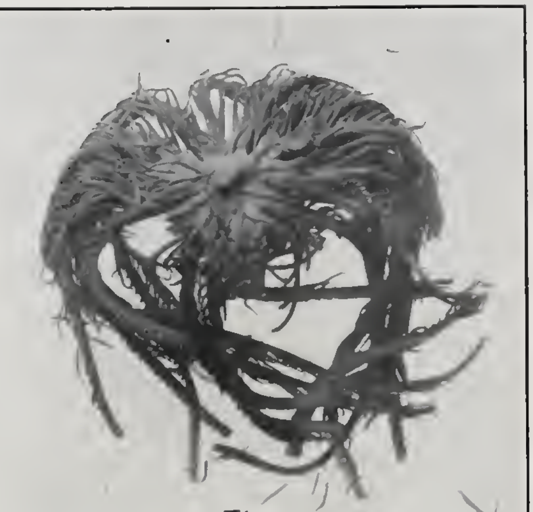

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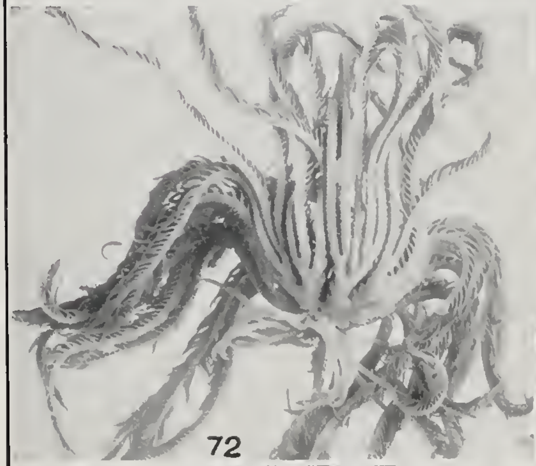

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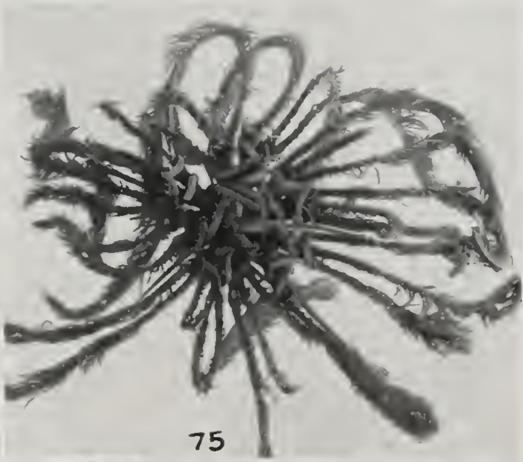

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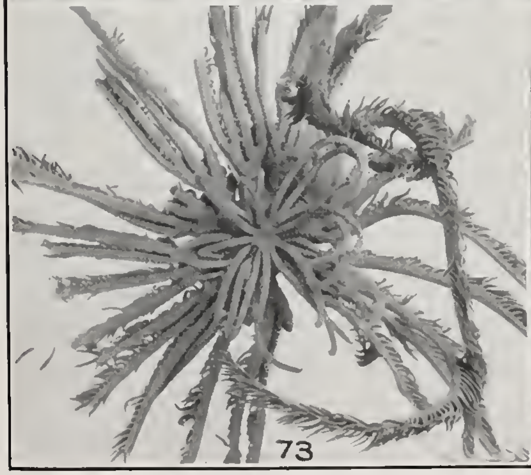

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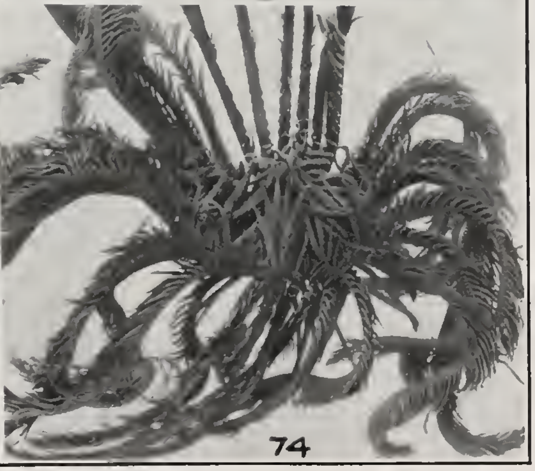

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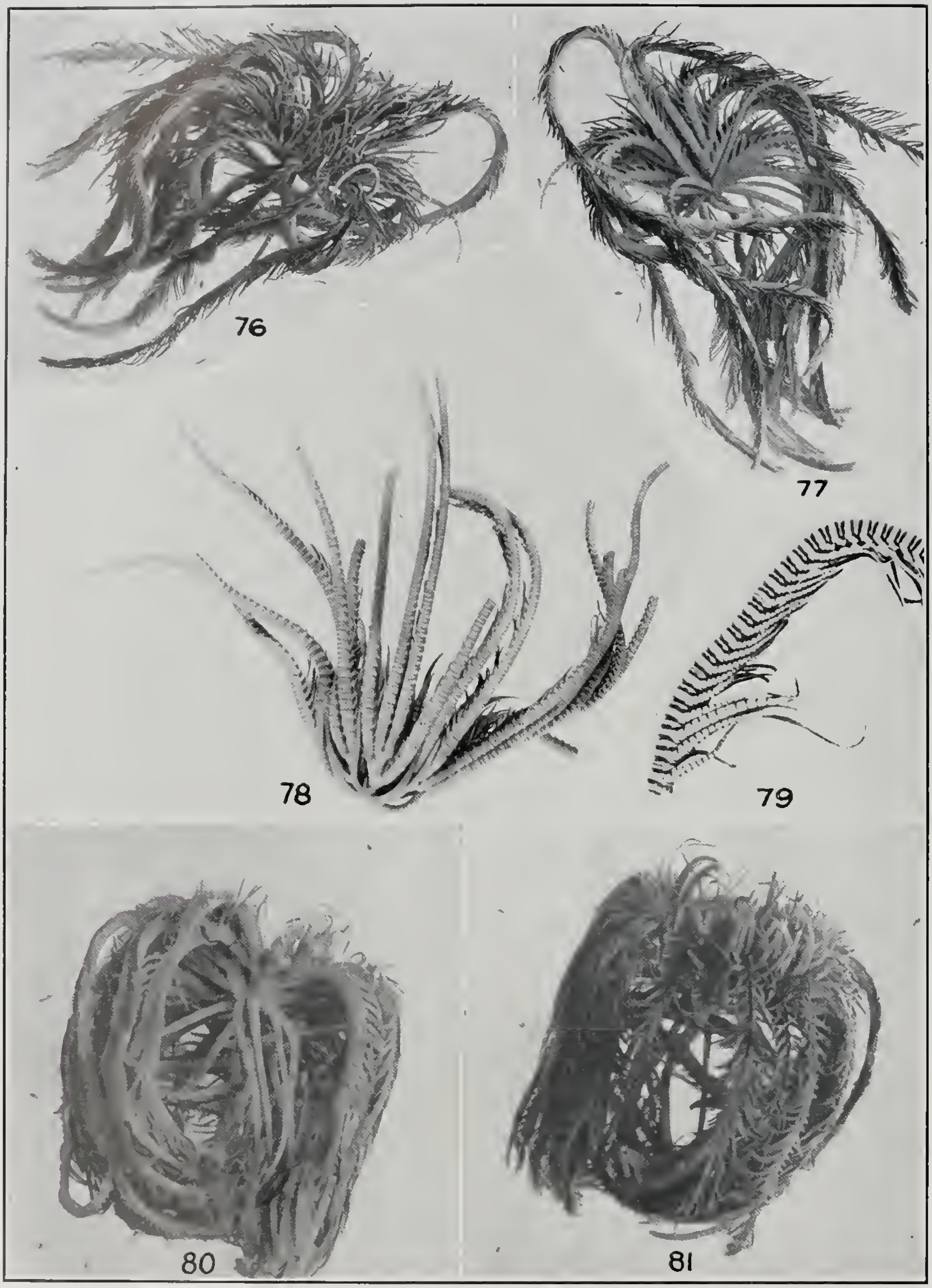
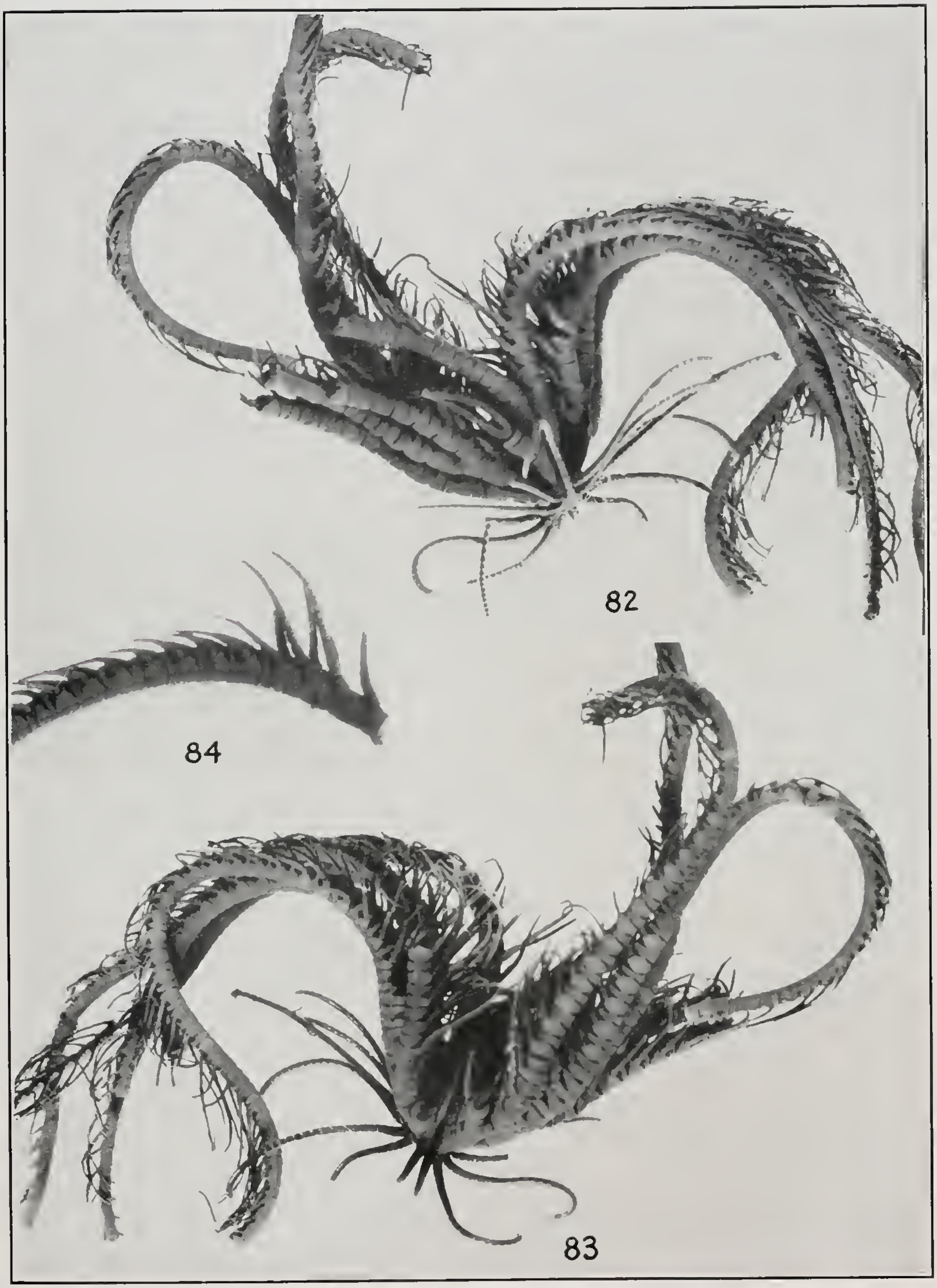
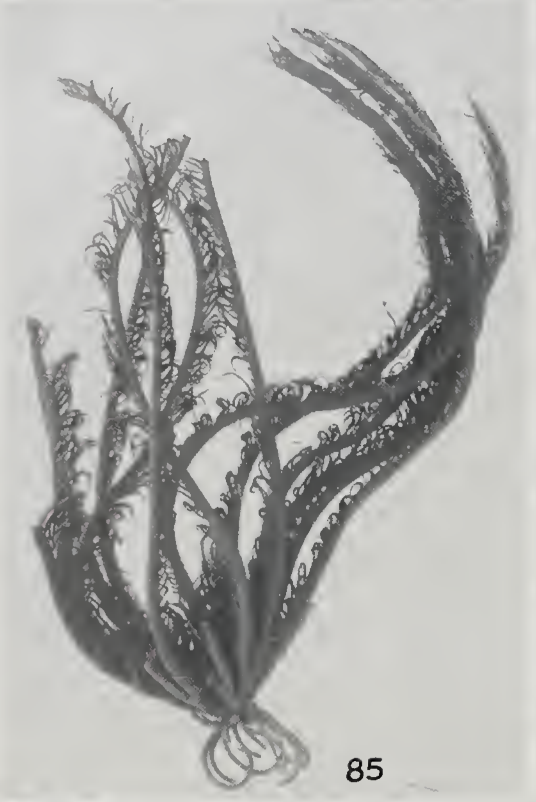
70, 71, *Himerometra persica:* The type specimen from the Persian Gulf (M. C. Z., 291).
72–75, *Himerometra martensi:* Specimens from Singapore (C. M.).



76–81, *Craspedometra acuticirra:* 76, 77, Specimen from Singapore (C. M.); 78, specimen from off Sumatra (lat. 3°40′ N., long. 99°10′ E.) in 16–18 meters (U.S.N.M., E. 3247); 79, same, proximal pinnules, × 2; 80, 81, specimen from Yé, Burma (I. M.).



82–84, *Heterometra savignii:* 82, 83, Specimen from the Red Sea, × 2 (U.S.N.M., 35081); 84, proximal pinnules of another specimen from the Red Sea, × 2 (U.S.N.M., 35213).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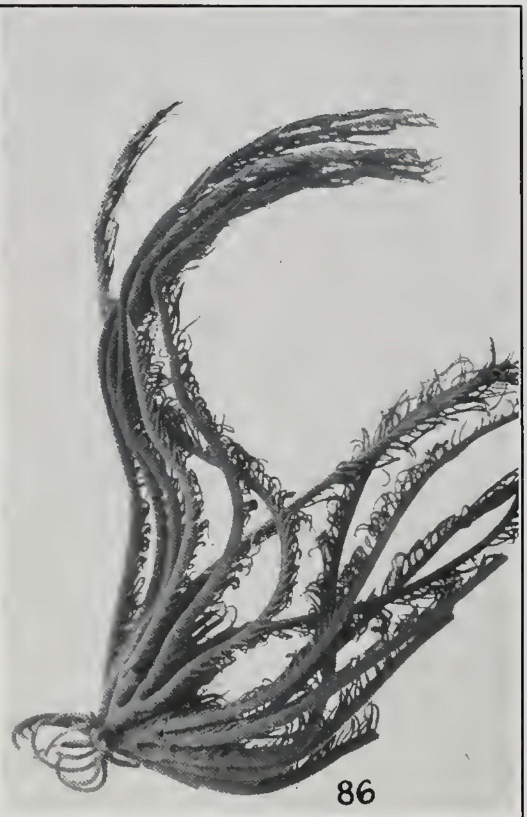
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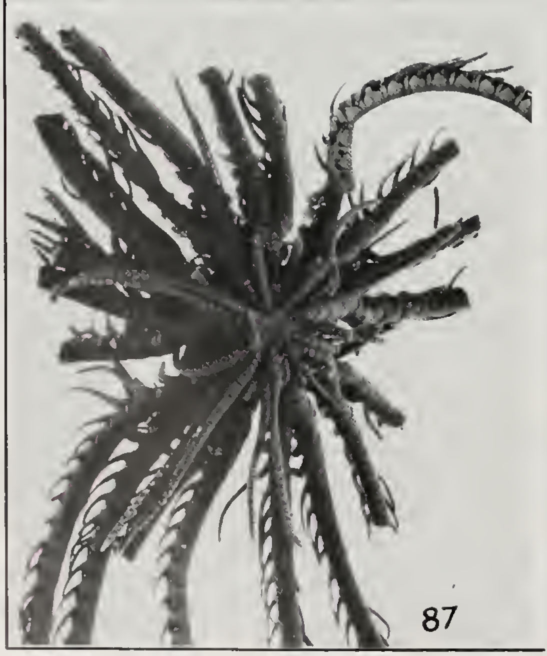
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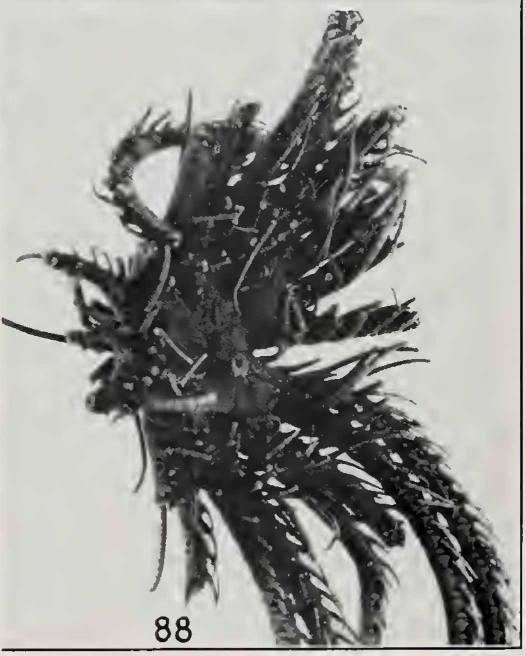
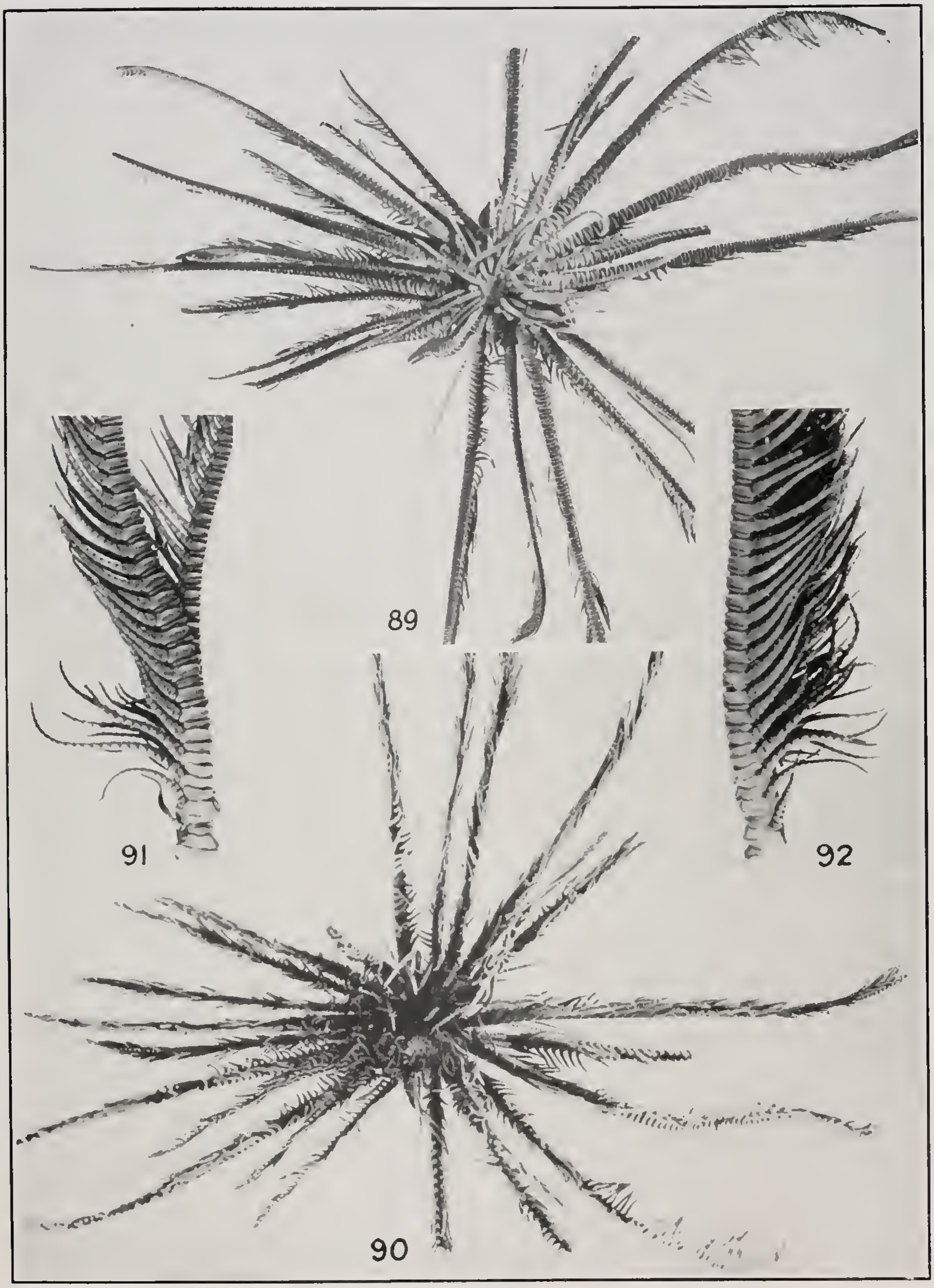
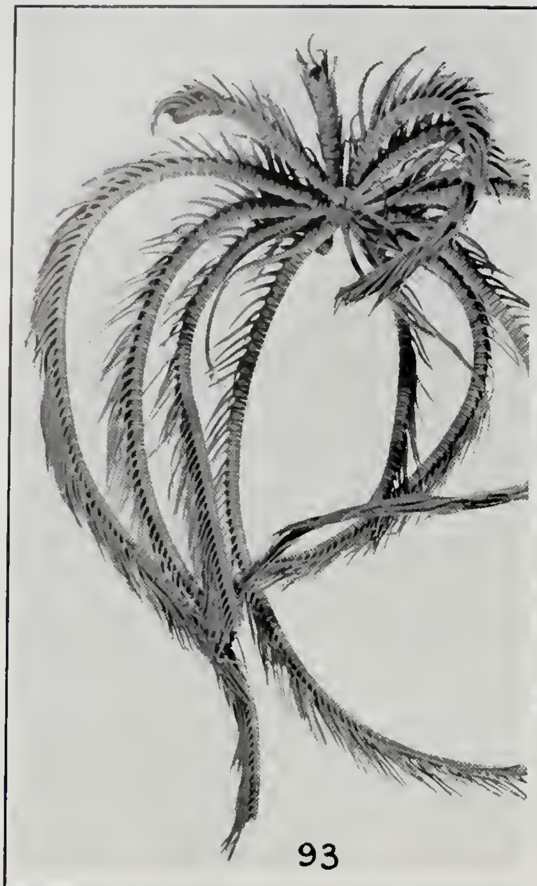

88

85–88, *Heterometra savignii:* 85, 86, The type specimen from the Red Sea (Berl. Mus., 1056); 87, 88, specimen from the Red Sea, × 2 (U.S.N.M., 35213) (see also fig. 84).



89–92, *Heterometra crenulata:* 89, 90, Specimen from Port Curtis, Queensland (U.S.N.M., 35207); 91, 92, same, proximal pinnules, × 2.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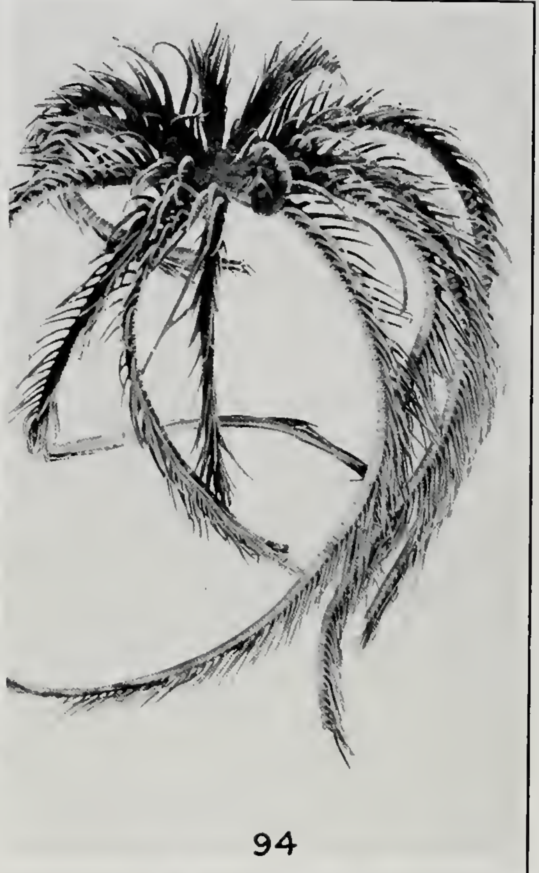
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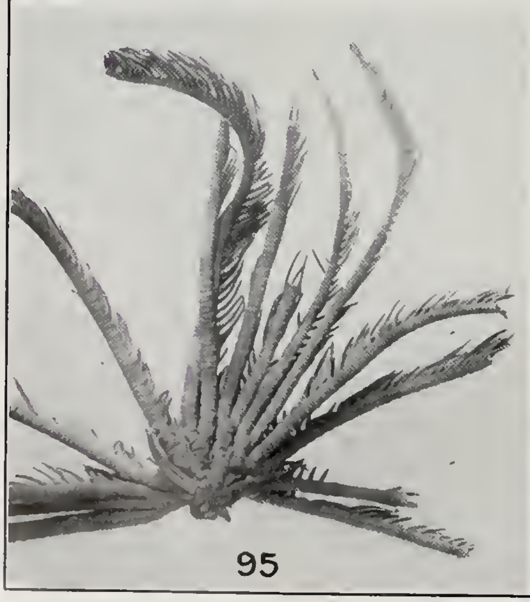
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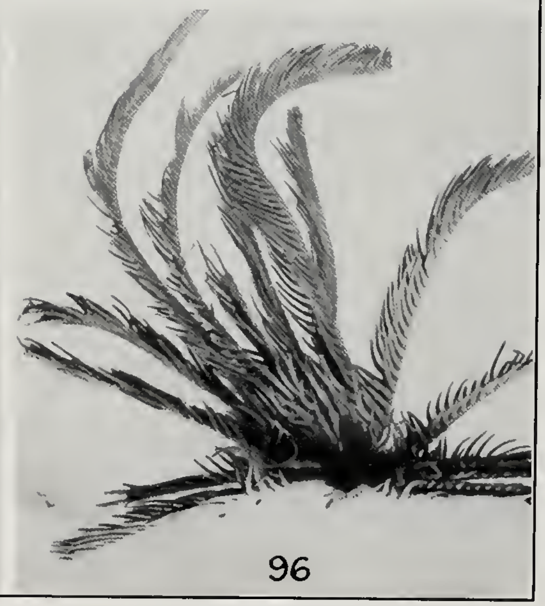
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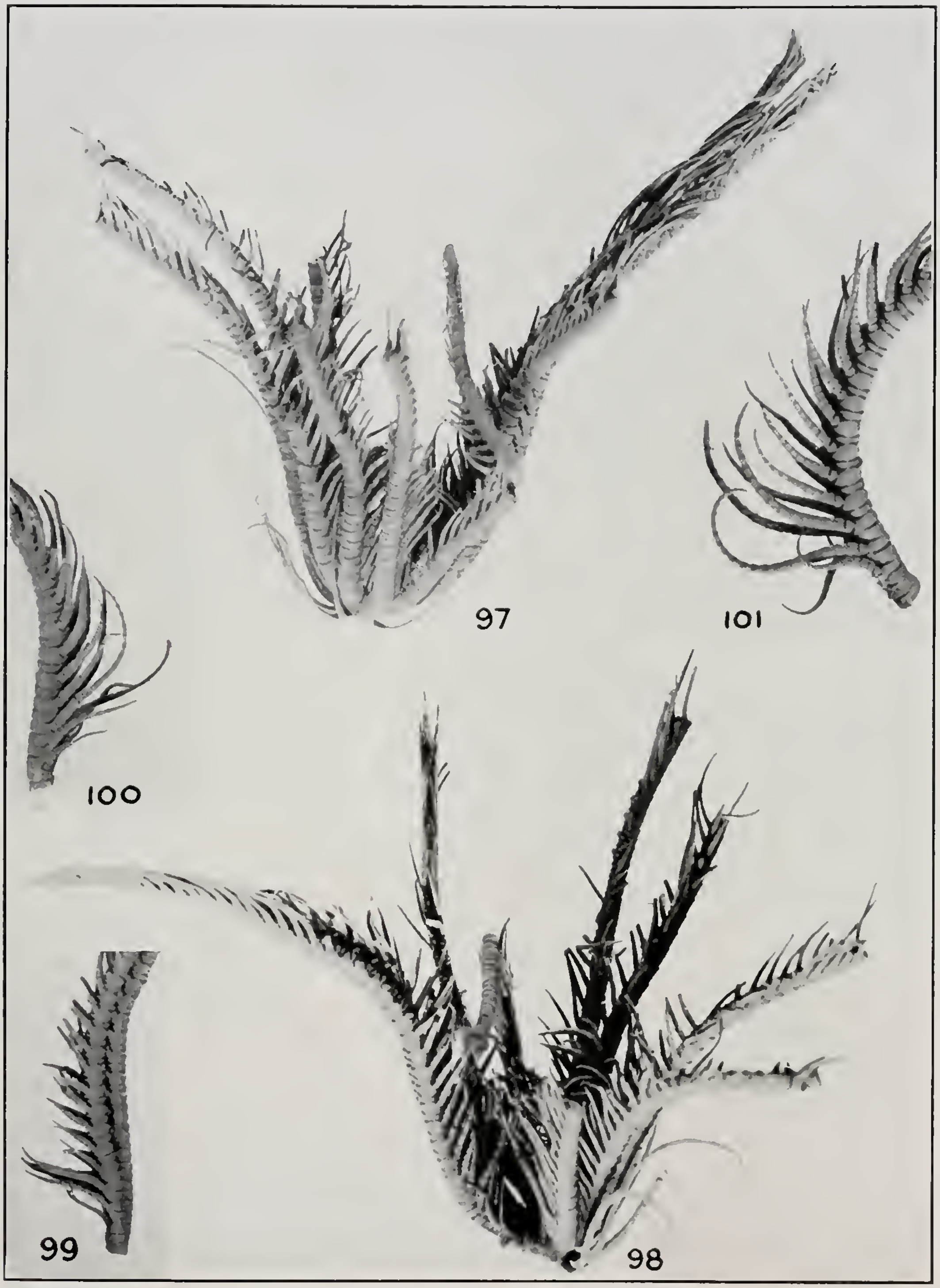
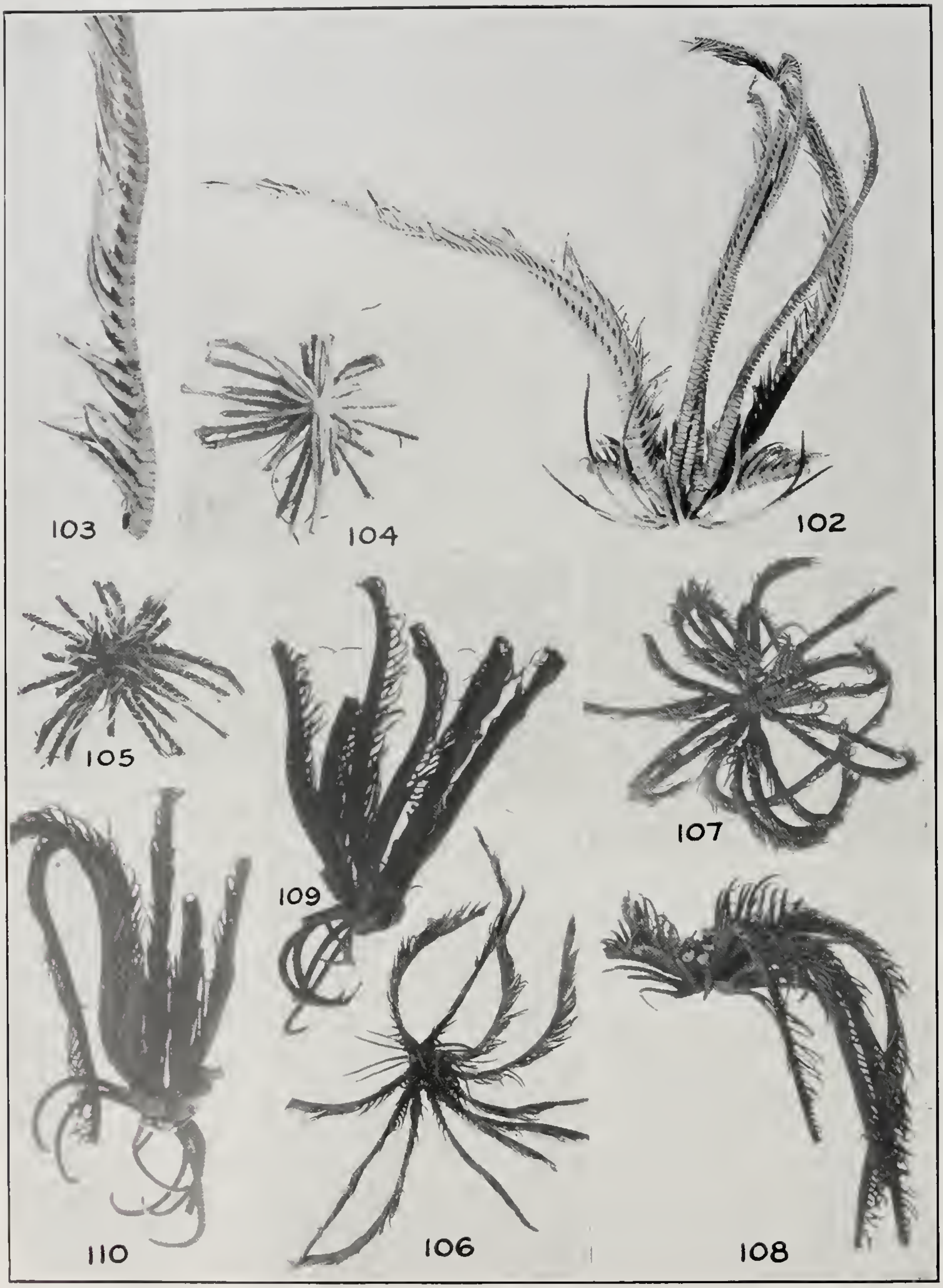
93–96, *Heterometra crenulata:* 93, 94, Specimen from *Albatross* station 5358 (U.S.N.M., 35181); 95, 96, specimen from Pocock Island in 36 meters (I. M.).



97–100, *Heterometra propinqua:* 97, 98, Cotype from *Siboga* station 318, × 2 (U.S.N.M., E. 431): 99, same, proximal pinnules, × 2; 100, proximal pinnules of a specimen from *Siboga* station 320, × 2 (U.S.N.M., E. 420).

101, *Heterometra crenulata:* Proximal pinnules of a specimen from *Albatross* station 5358 (U.S.N.M., 35181) (see also figs. 93, 94).



102, 103, *Heterometra crenulata:* 102, Type specimen of *Craspedometra aliena* from *Albatross* station 5157 (U.S.N.M., 25516); 103, same, proximal pinnules, × 2.

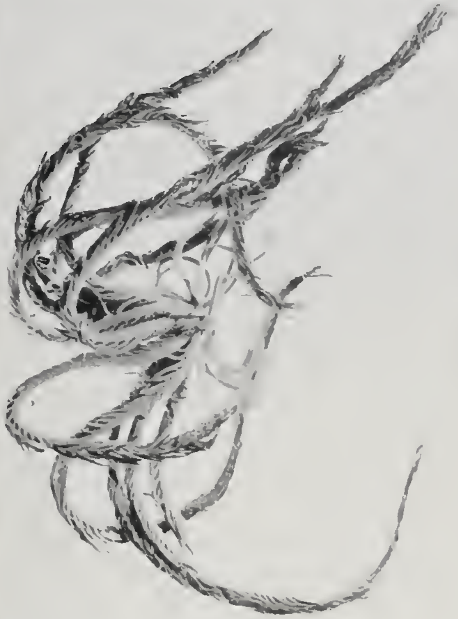
104, 105, *Heterometra variipinna:* The type specimen from "Canton" (H. M.).

106, *Heterometra producta:* The type specimen from Singapore (C. M.).

107, *Heterometra quinduplicava:* Specimen from Singapore (C. M.).

108, *Heterometra africana:* The type specimen from Bagamoyo, Tanganyika Territory (Berl. Mus., 4616).

109, 110, *Heterometra ater:* The type specimen from the Red Sea (Berl. Mus., 1055).



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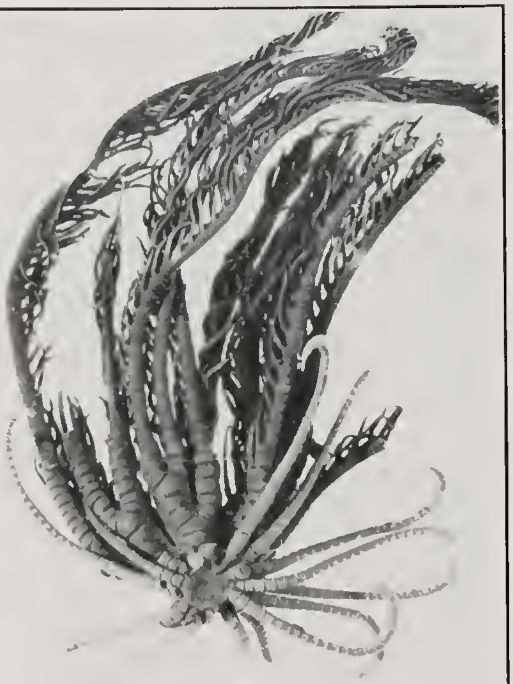

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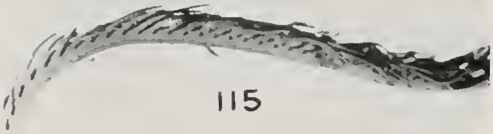

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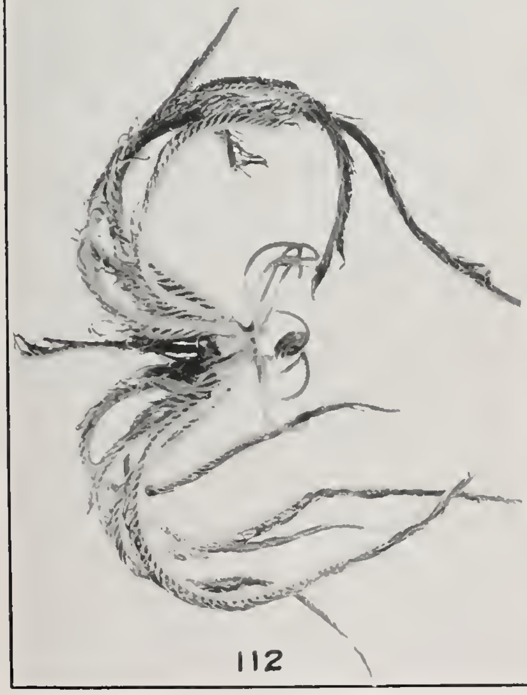

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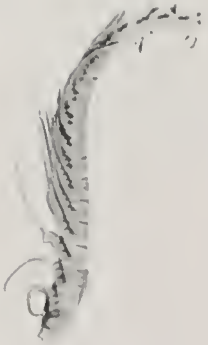

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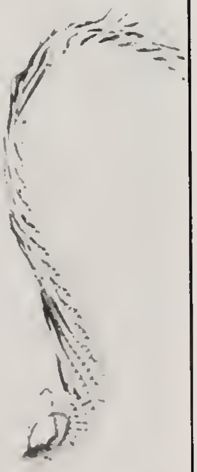
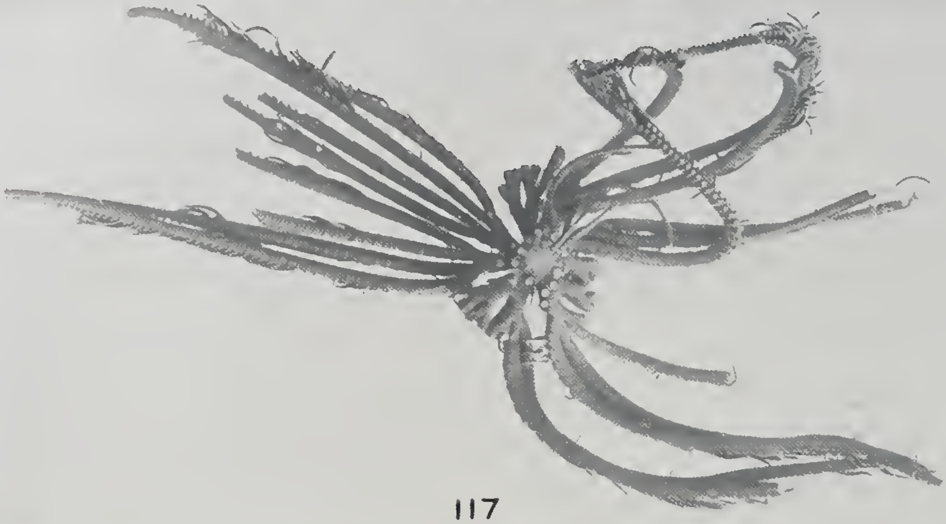


114

111–116, *Heterometra africana:* 111, 112, Specimen from *Investigator* station 291 (U.S.N.M., 35180); 113–115, same, proximal pinnules, × 2; 116, specimen from ?Kurrachi (U.S.N.M., 35189).



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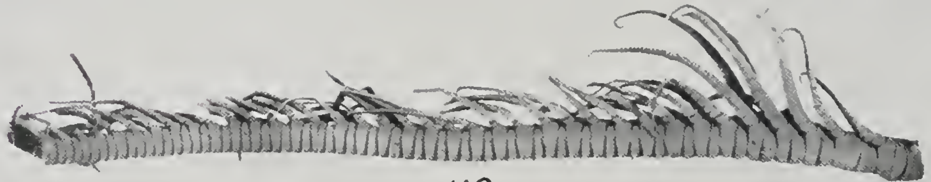

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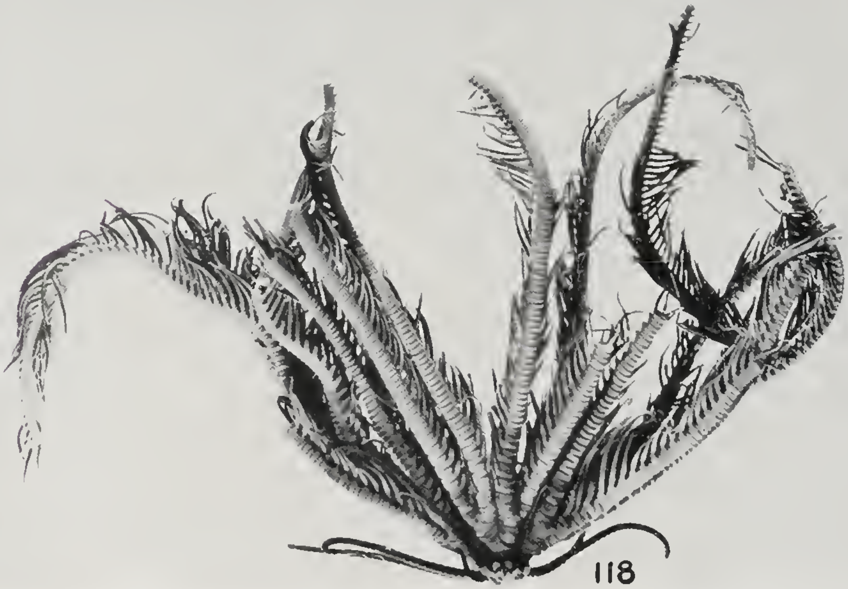
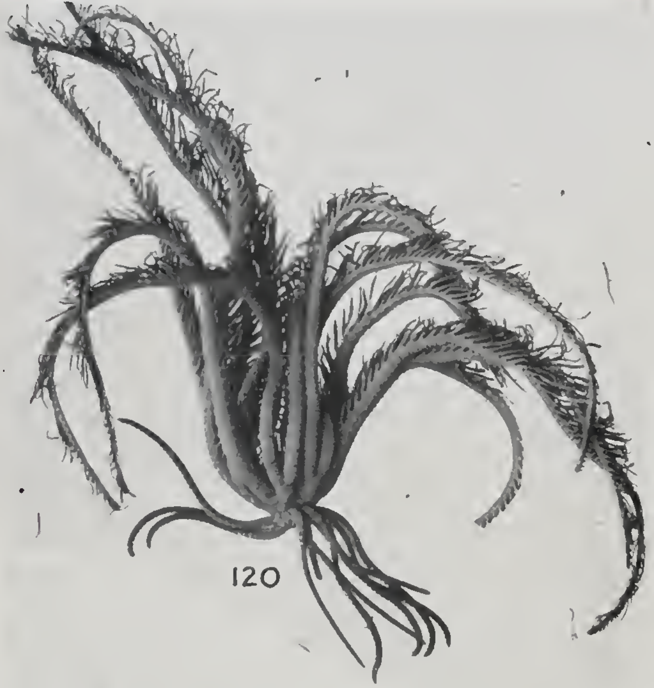


118

117, *Heterometra nematodon:* The type specimen from Bowen, Queensland (H. M.).
118, 119, *Heterometra philiberti:* 118, Specimen from the Andaman Islands, collected by the *Investigator* (U.S.N.M., 35219); 119, same, proximal pinnules, × 2.



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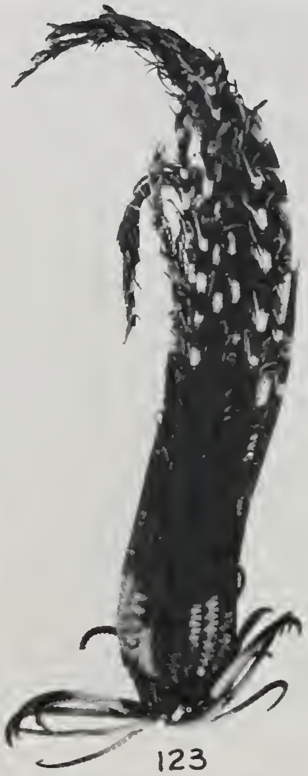

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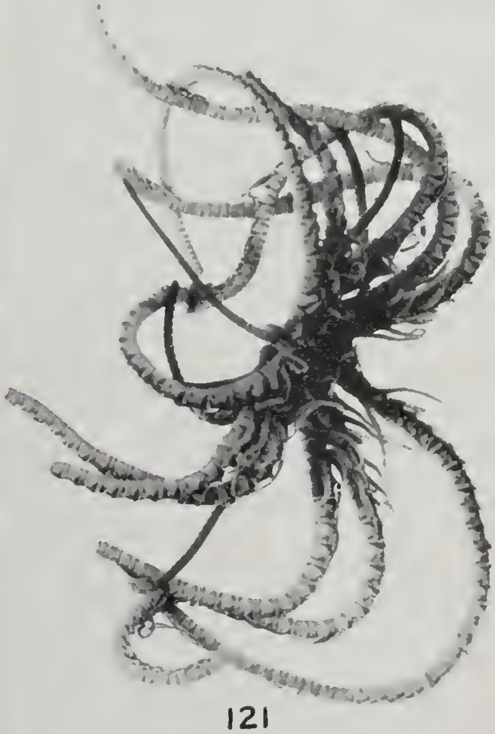

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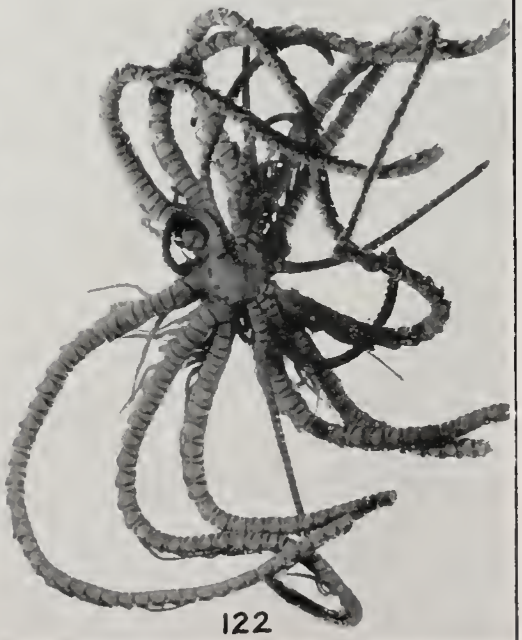

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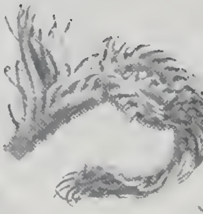
120–122, *Heterometra madagascarensis:* 120, The type specimen from Madagascar (Berl. Mus., 5348); 121, 122, a young individual from Madagascar, × 2 (U.S.N.M., 35216).

123, *Heterometra amboinae:* Specimen collected at Amboina by the Danish Expedition to the Kei Islands (U.S.N.M., E. 3217).



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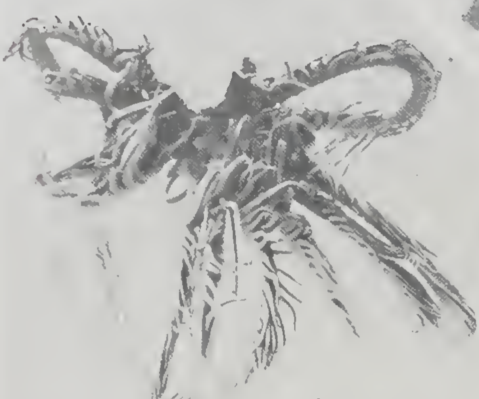

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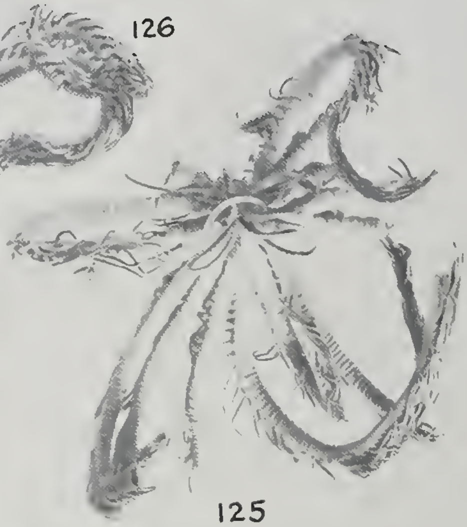

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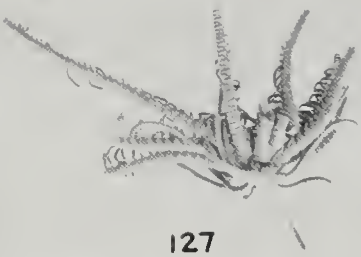

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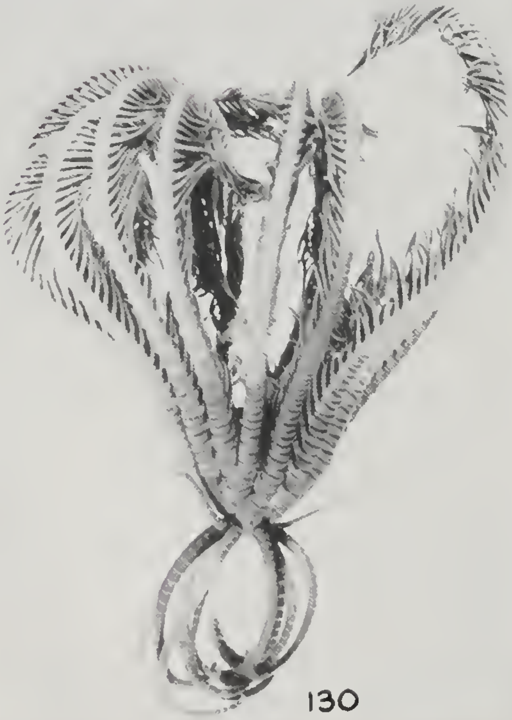

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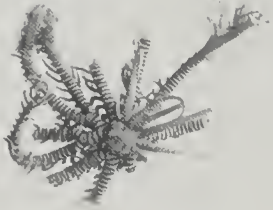

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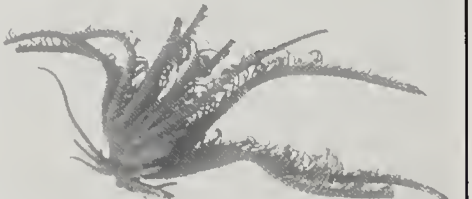

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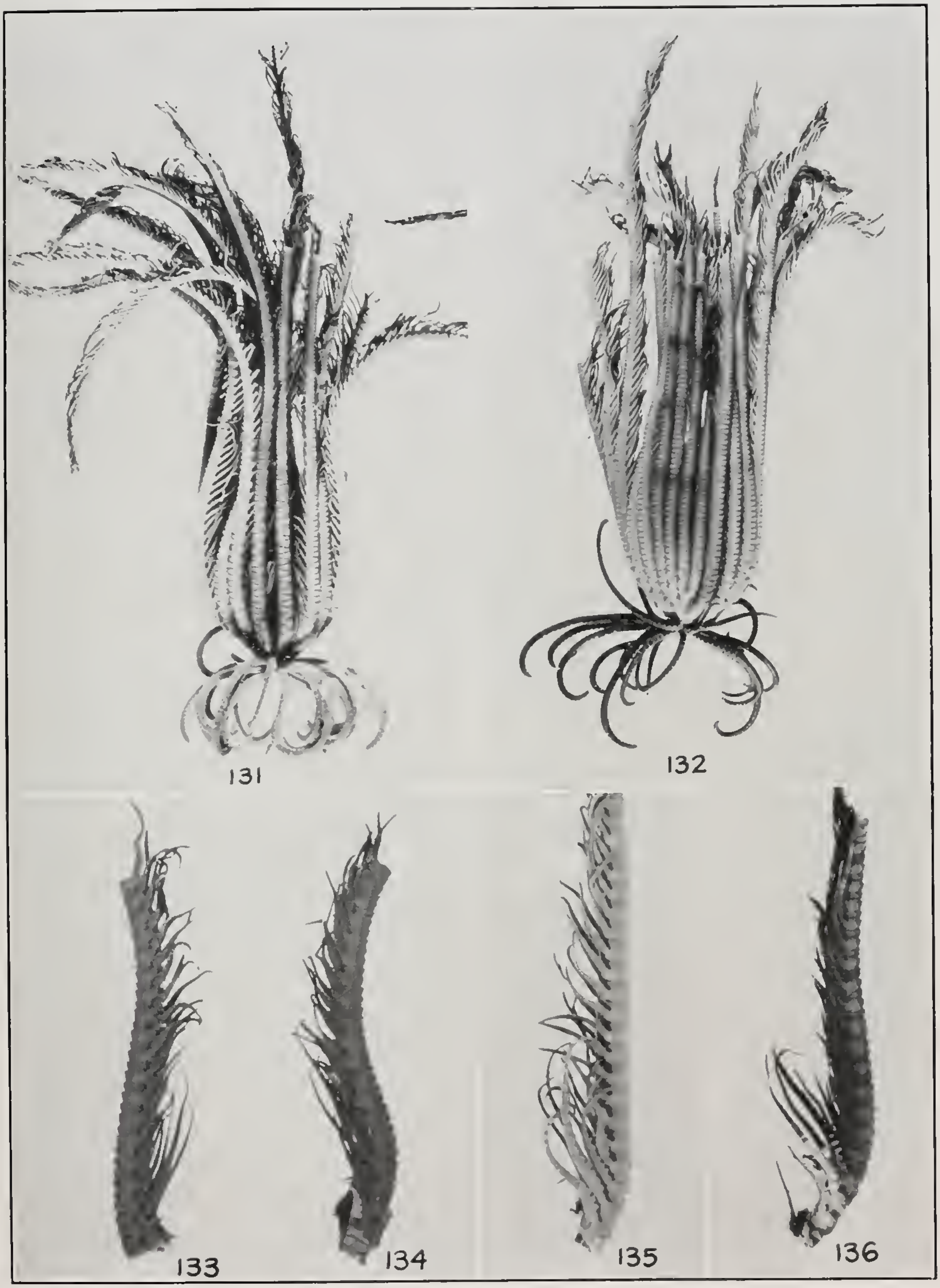
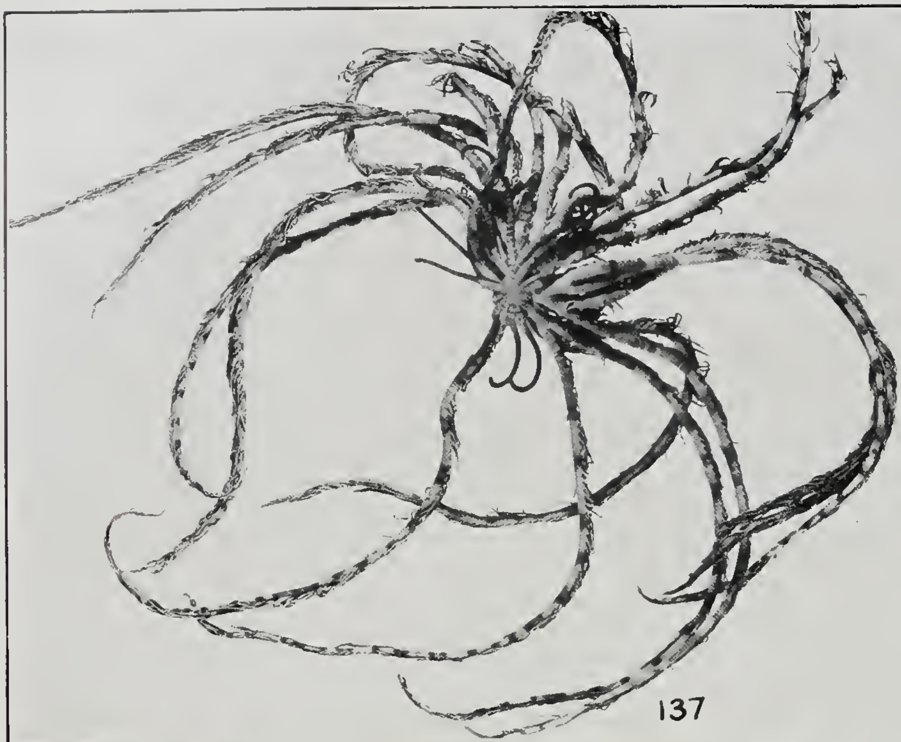
124–126, *Heterometra philiberti:* 124, 125, The type specimen of *Amphimetra mortenseni* from Port Blair, Andaman Islands, collected by the *Investigator* (I. M.); 126, same, proximal pinnules, × 2.

127–130, *Heterometra bengalensis:* 127, 128, Specimen from Singapore in 13 meters (B. M.); 129, the type specimen of *H. aspera* from Singapore (C. M.); 130, specimen from Singapore, × 2 (U.S.N.M., E. 3134).



131–136, *Heterometra amboinae:* 131, 132, Two specimens from Amboina Bay collected by the Danish Expedition to the Kei Islands (U.S.N.M., E. 3219); 133–136, same, proximal pinnules, × 2.



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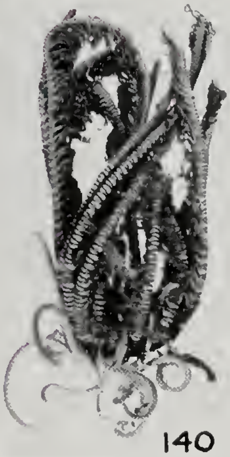

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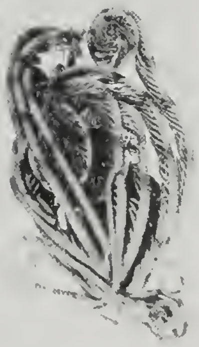

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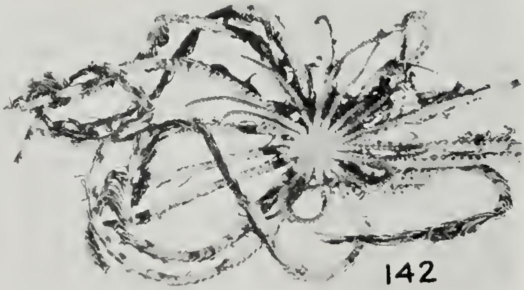

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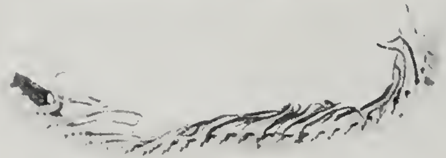

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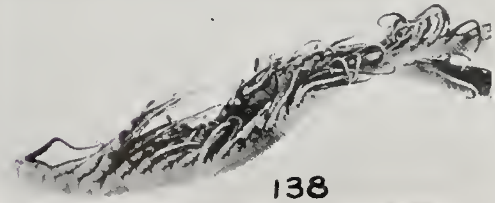

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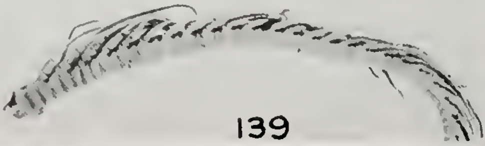

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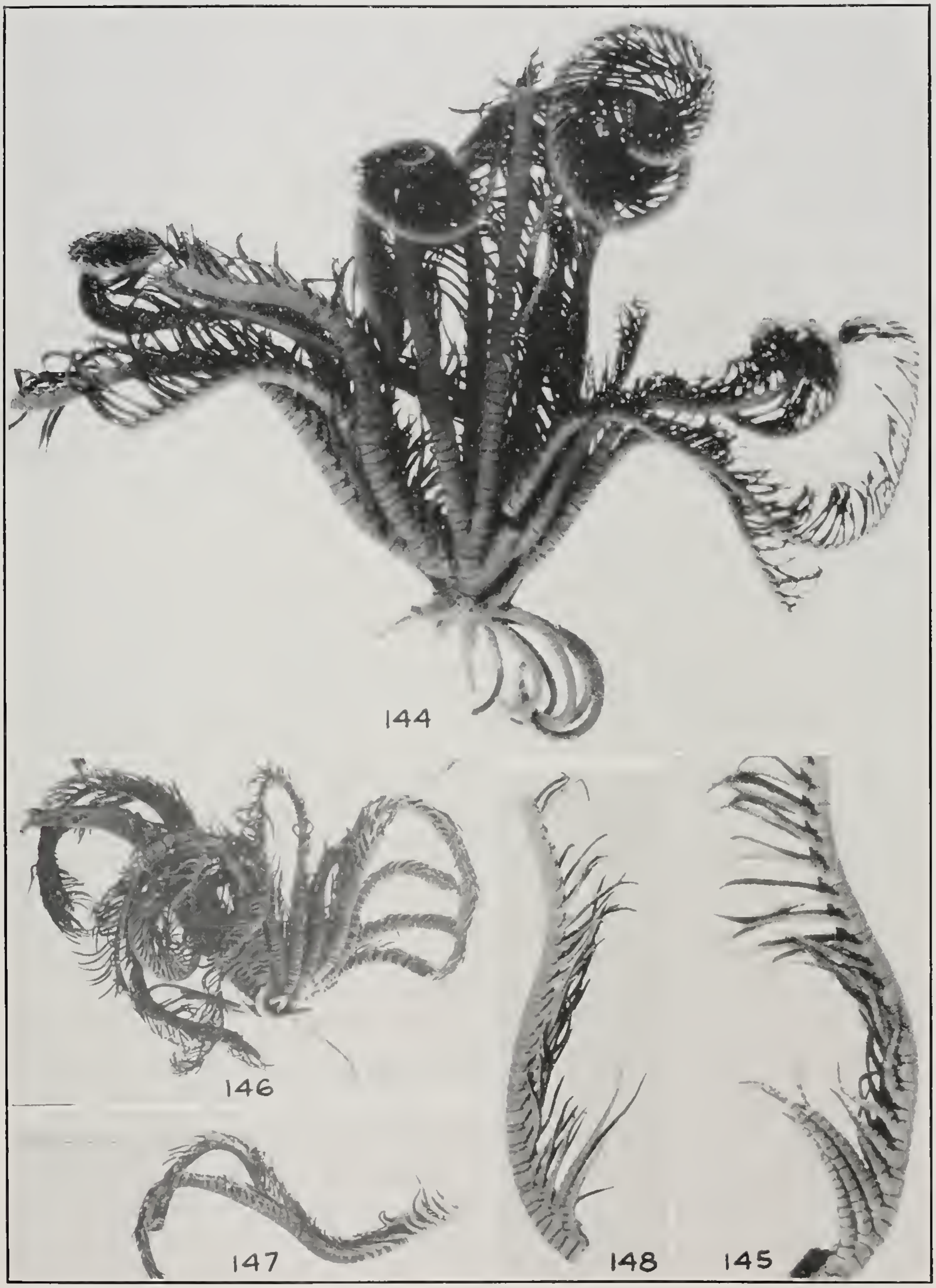
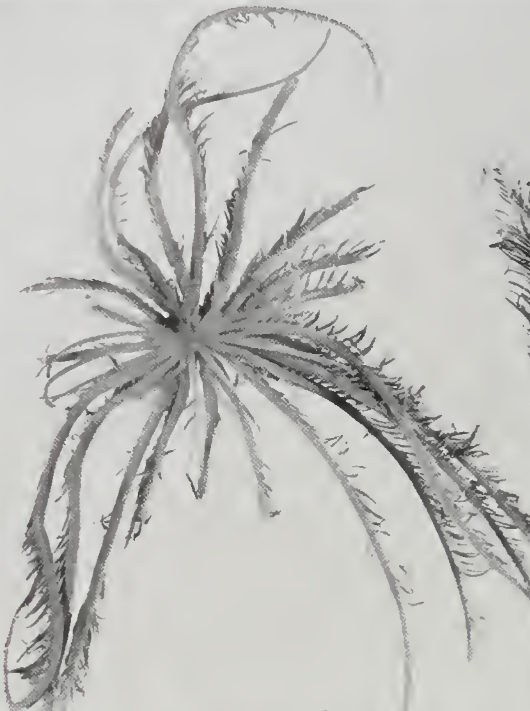
137–143, *Heterometra reynaudi:* 137, Specimen from off Gopalpore in 55–69 meters, collected by the *Golden Crown* (U.S.N.M., 35109); 138, 139, same, proximal pinnules; 140–142, specimens from off Gopalpore in 46–51 meters, collected by the *Golden Crown* (U.S.N.M., 35113); 143, same, proximal pinnules.



144–148, *Heterometra compta:* 144, Specimen from the Pedro Shoal, × 2 (U.S.N.M., 35209); 145, same, proximal pinnules, × 2; 146, the type specimen from the Pedro Shoal (I. M.); 147, same, proximal pinnules; 148, proximal pinnules of another specimen from the Pedro Shoal, × 2 (U.S.N.M., 35088).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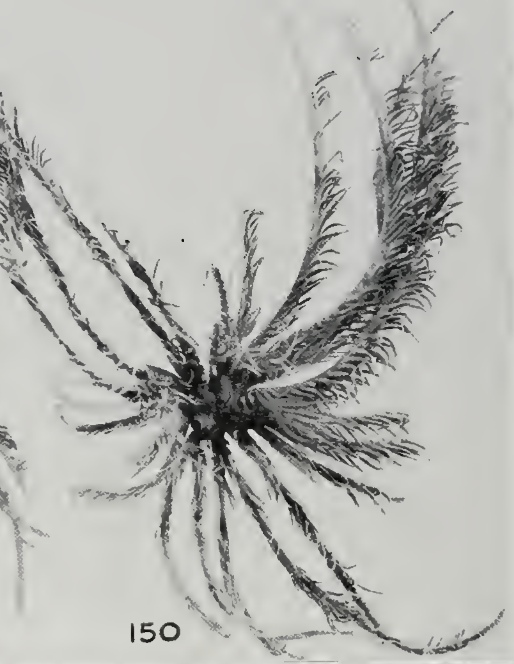
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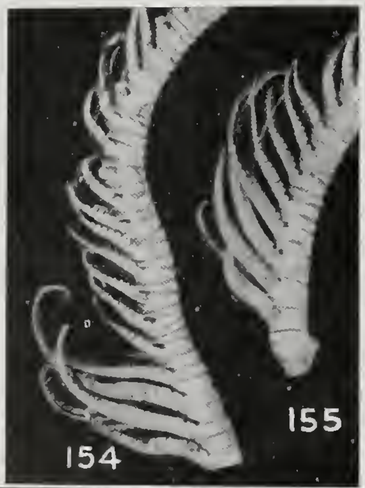
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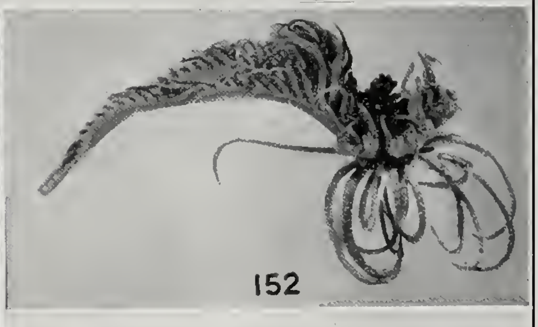
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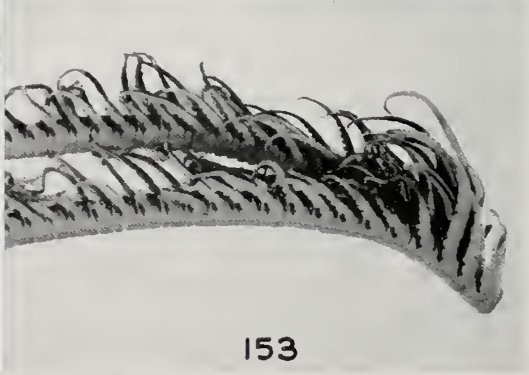
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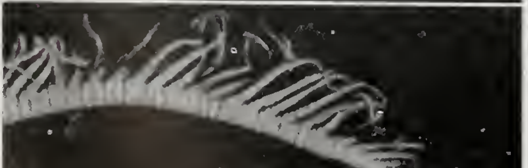
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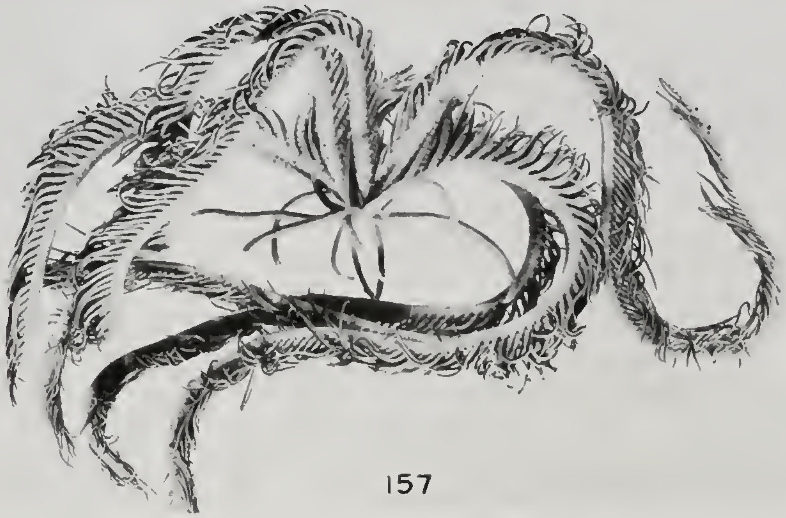
149–151, *Heterometra quinduplicava:* 149, 150, Cotype of *H. apollo* from lat. 6°05′ S., long. 105°42′ E., in 52 meters, collected by the Danish Expedition to the Kei Islands (U.S.N.M., E. 3200); 151, same, proximal pinnules, × 2.

152–156, *Heterometra astyanax:* 152, The type specimen from lat, 5°54′ S., long. 106°12′ E., in 24 meters, collected by the Danish Expedition to the Kei Islands (C. M.); 153–156, same, proximal (153–155) and distal (156) pinnules, × 2.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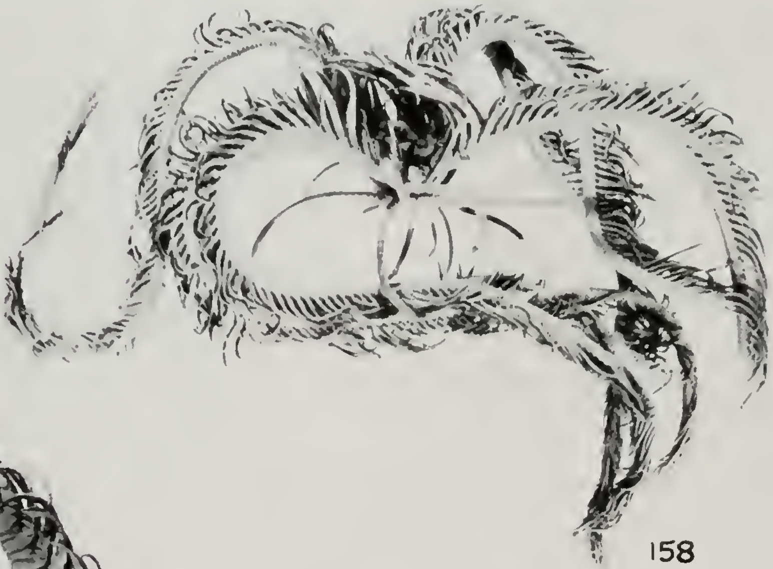
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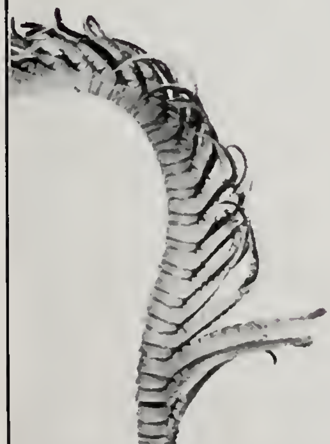
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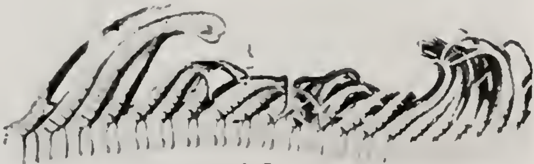
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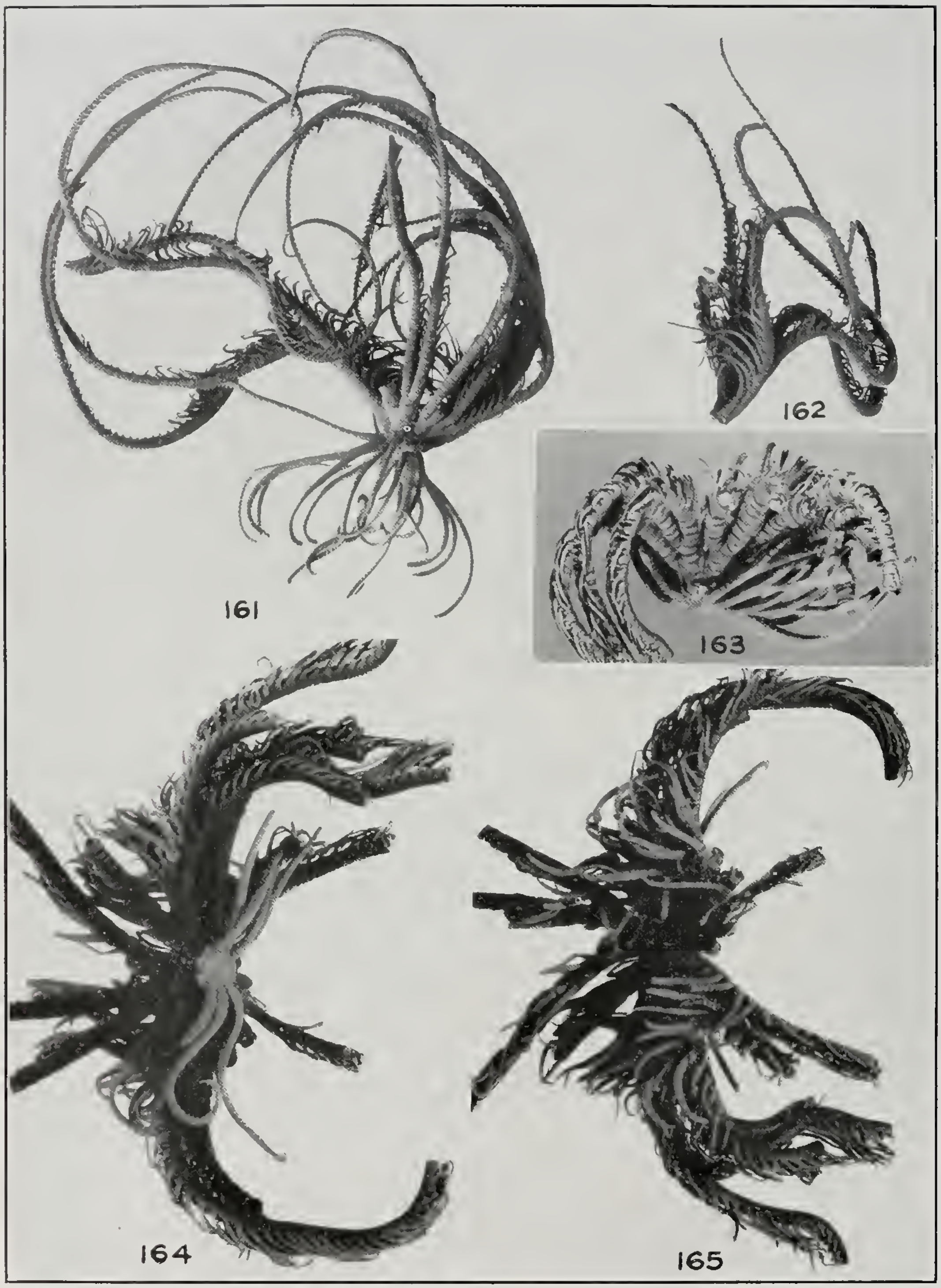
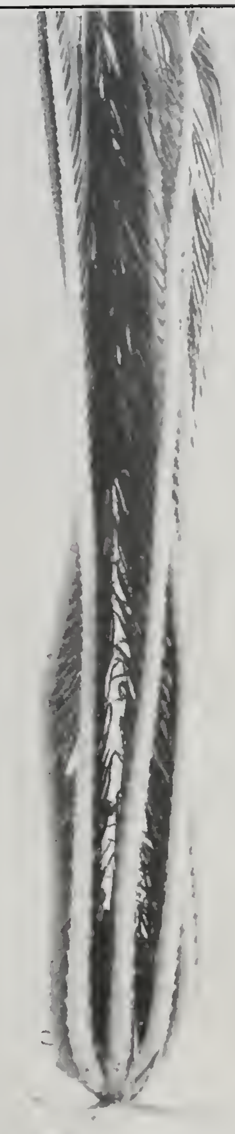
157–160, *Heterometra parilis:* 157, 158, The type specimen from *Albatross* station 5147 (U.S.N.M., 25515); 159, 160, same proximal pinnules, × 2.



161–163, *Heterometra singularis:* 161, Specimen from 80 miles northwest of Penang in 73 meters, collected by the *Patrol* (B. M.); 162, same, proximal pinnules; 163, specimen from *Investigator* station 548, × 1½ (I. M.).

164, 165, *Heterometra pulchra:* Specimen from lat. 3°40′ N., long. 99°10′ E., in 29–33 meters, × 2 (U.S.N.M., E. 3246).



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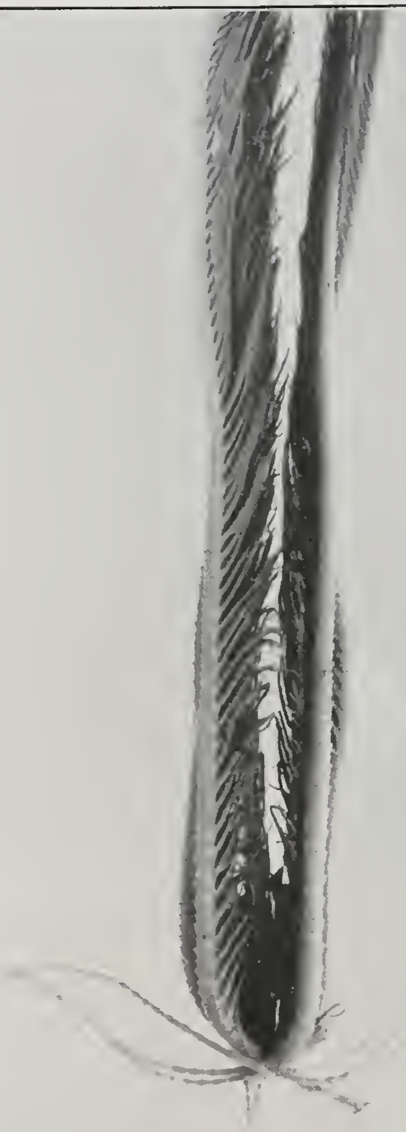

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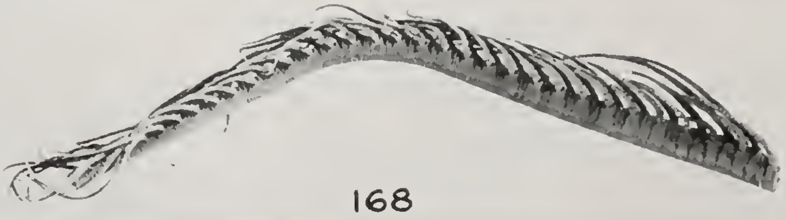
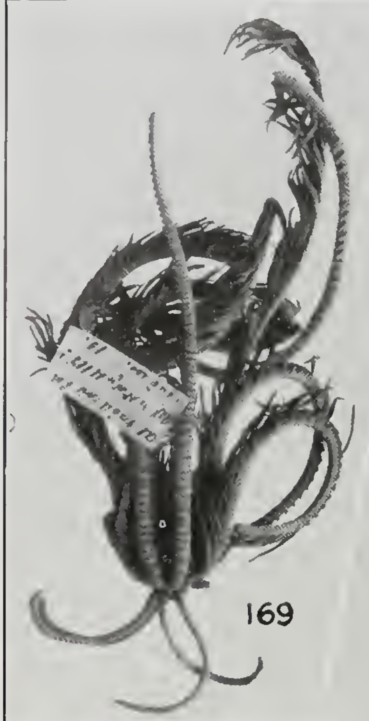


168

166, 167, *Homalometra denticulata:* Specimen from *Siboga* station 167, × 2 (Amsterdam Mus.).
168, *Oxymetra finschii:* Proximal pinnules of a cotype from New Britain, × 2 (U.S.N.M., 35268).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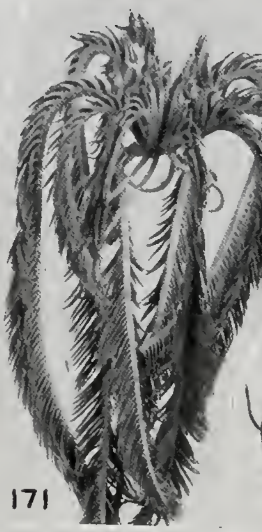
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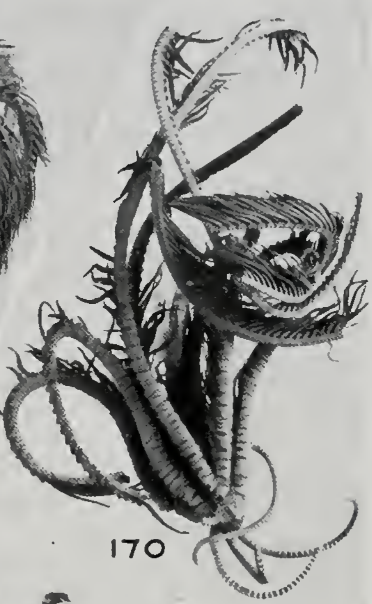
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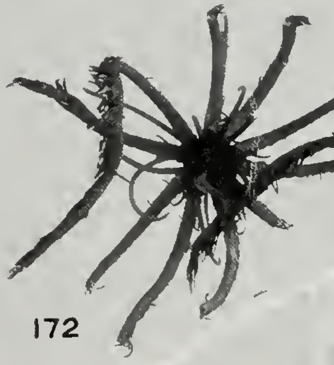
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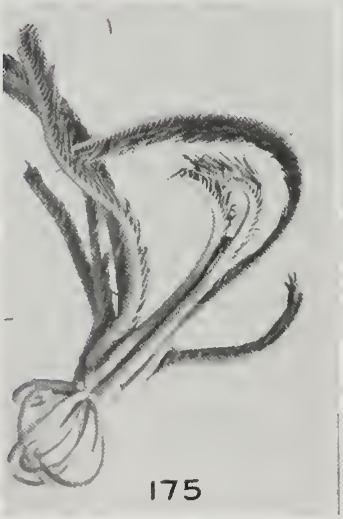
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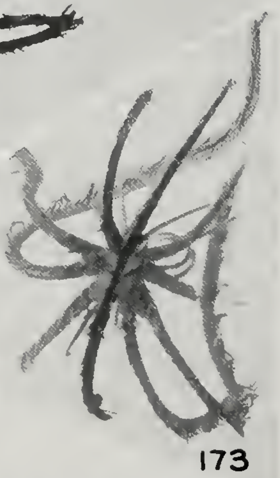
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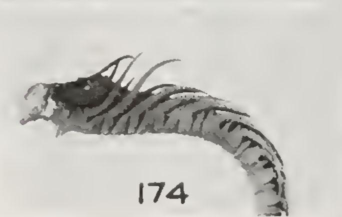
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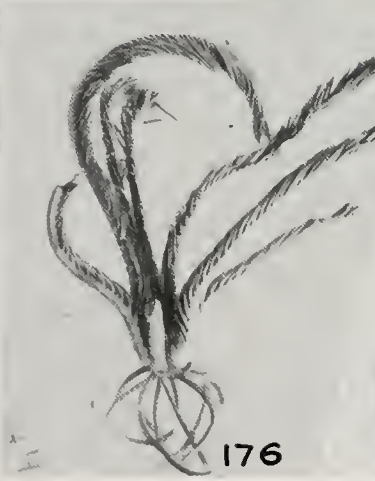
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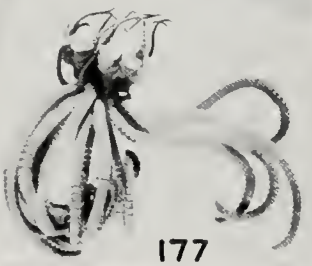
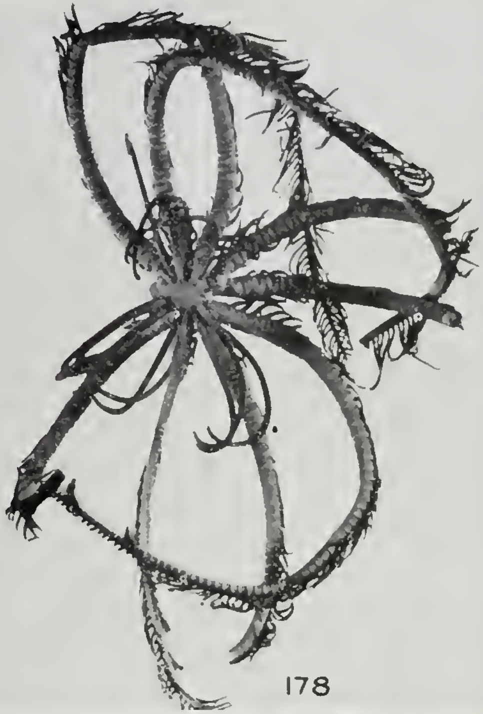

177

169–171, *Amphimetra molleri:* 169, 170, The type specimen from the "Indian Ocean" (C. M.); 171, specimen from Singapore (C. M.).

172–174, *Amphimetra ensifer:* 172, 173, The type specimen from Singapore (C. M.); 174, proximal pinnules of a specimen from Singapore, × 2 (U.S.N.M., E. 1083).

175, 176, *Amphimetra laevipinna*, the type specimen from "Canton" (H. M.).

177, *Amphimetra spectabilis:* Specimen from the south channel to Manila Bay in 64 meters, collected by the *Albatross* (U.S.N.M., 35245) (see also figs. 183, 184).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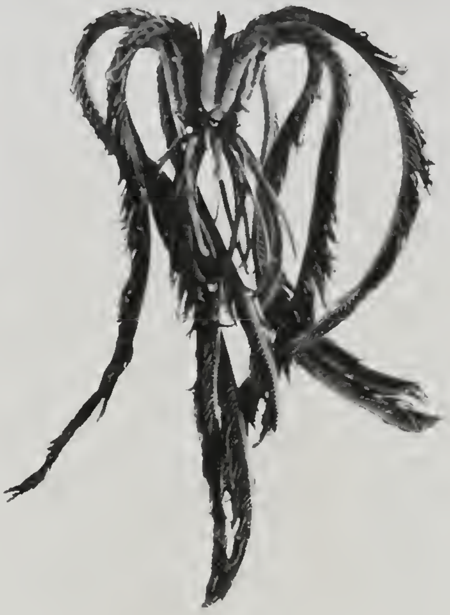
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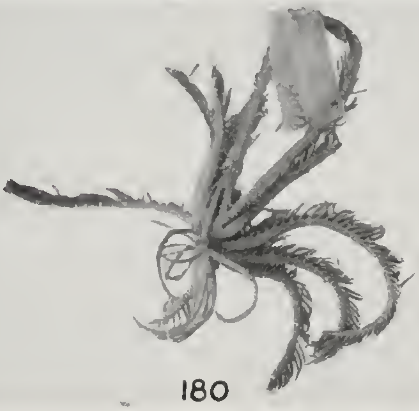
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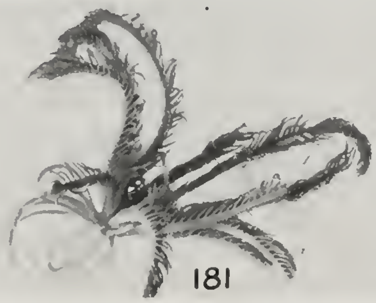
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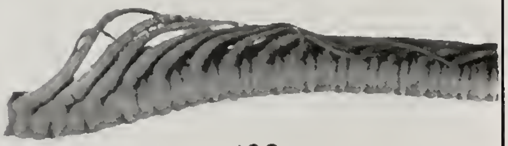
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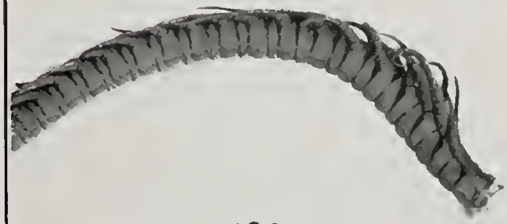
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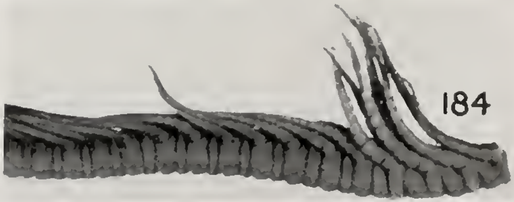
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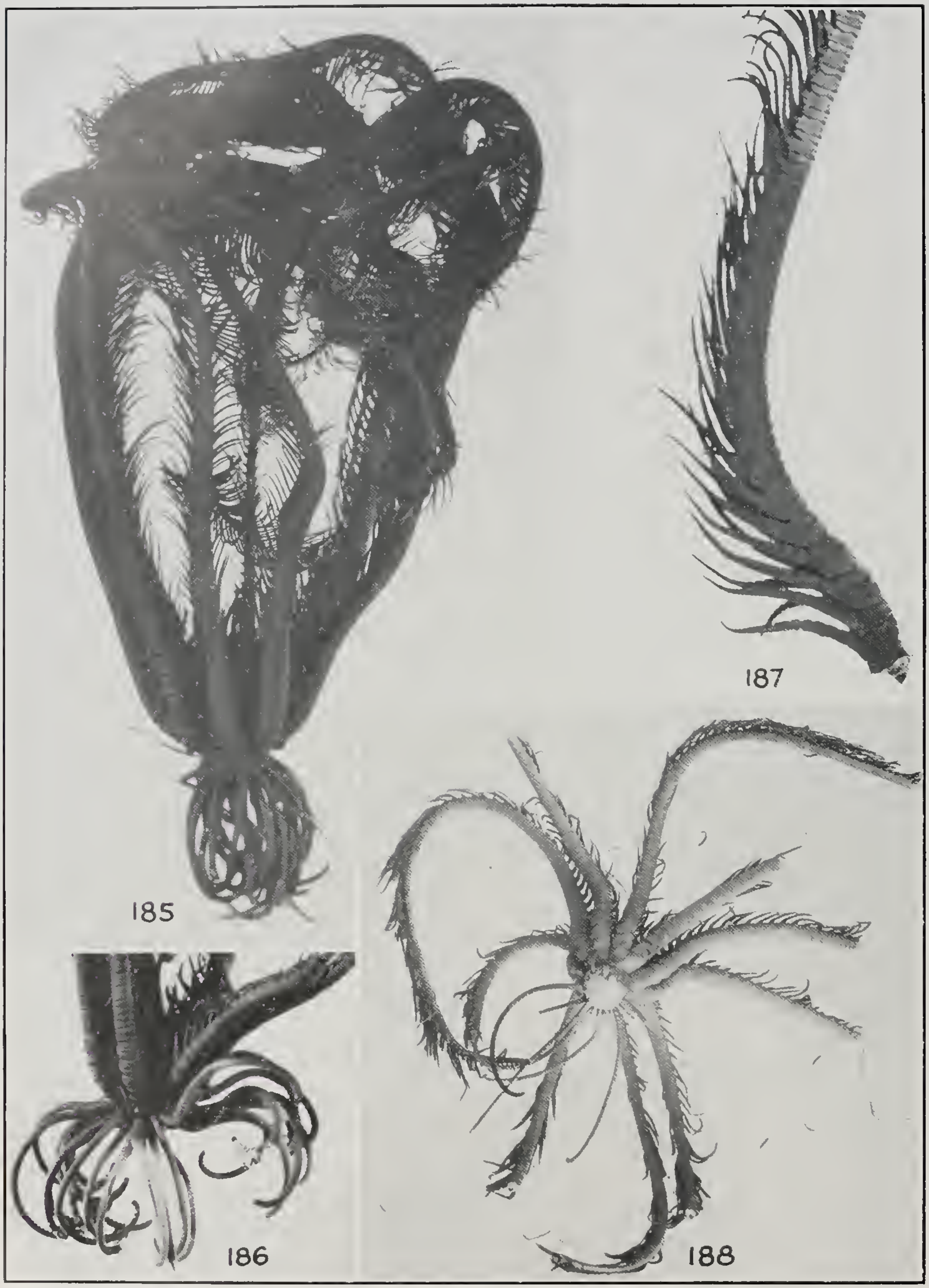
178, 182, *Amphimetra discoidea:* 178, The type specimen from Port Denison, Queensland (U.S.N.M., 25453); 182, same proximal pinnules, × 2.

179, *Amphimetra ensifer:* Specimen from Singapore (U.S.N.M., E. 1083).

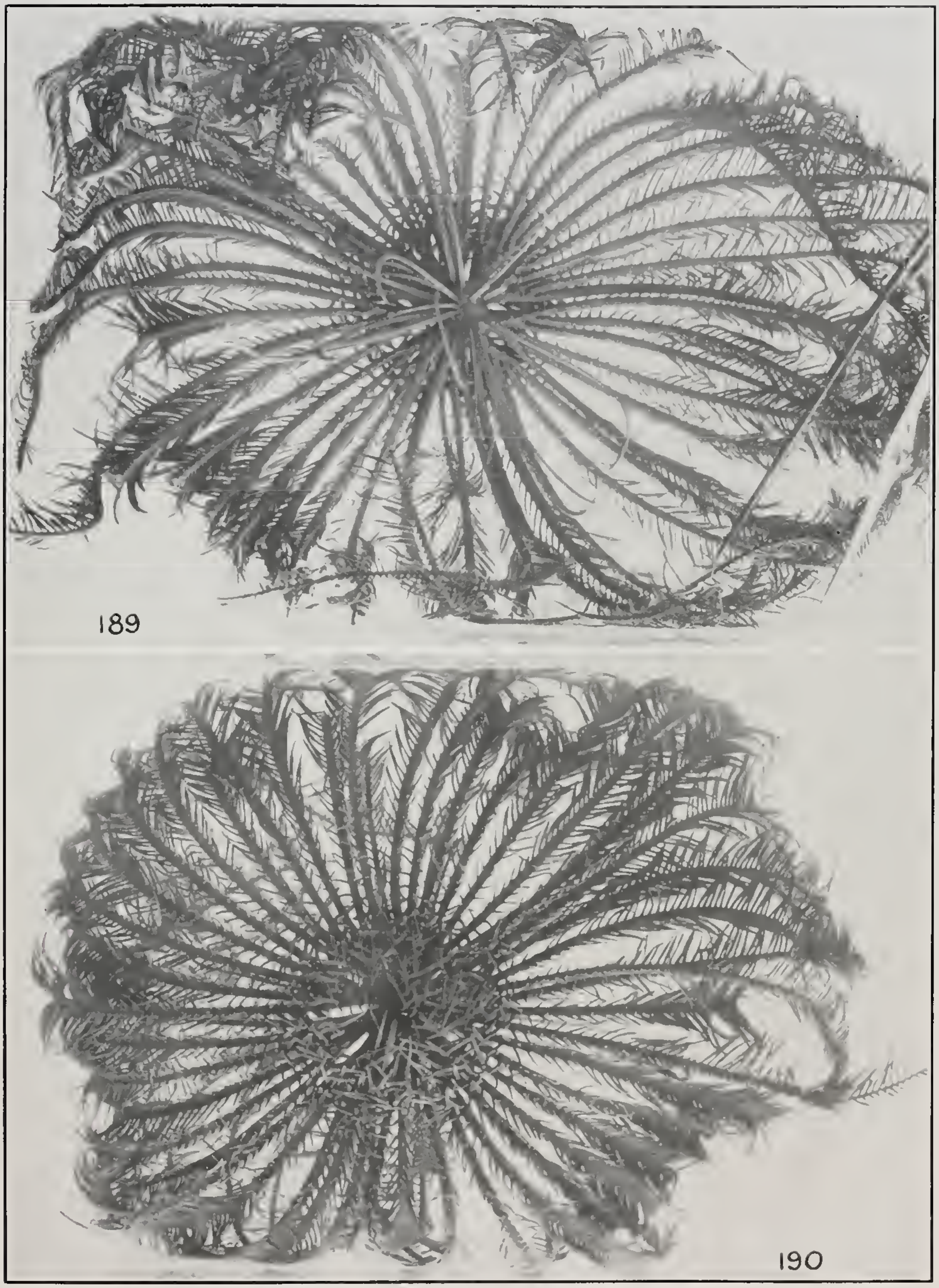
180, 181, *Heterometra schlegelii:* The type specimen from Japan (C. M.).

183, 184, *Amphimetra spectabilis:* Proximal pinnules of specimen shown in fig. 177, × 2.

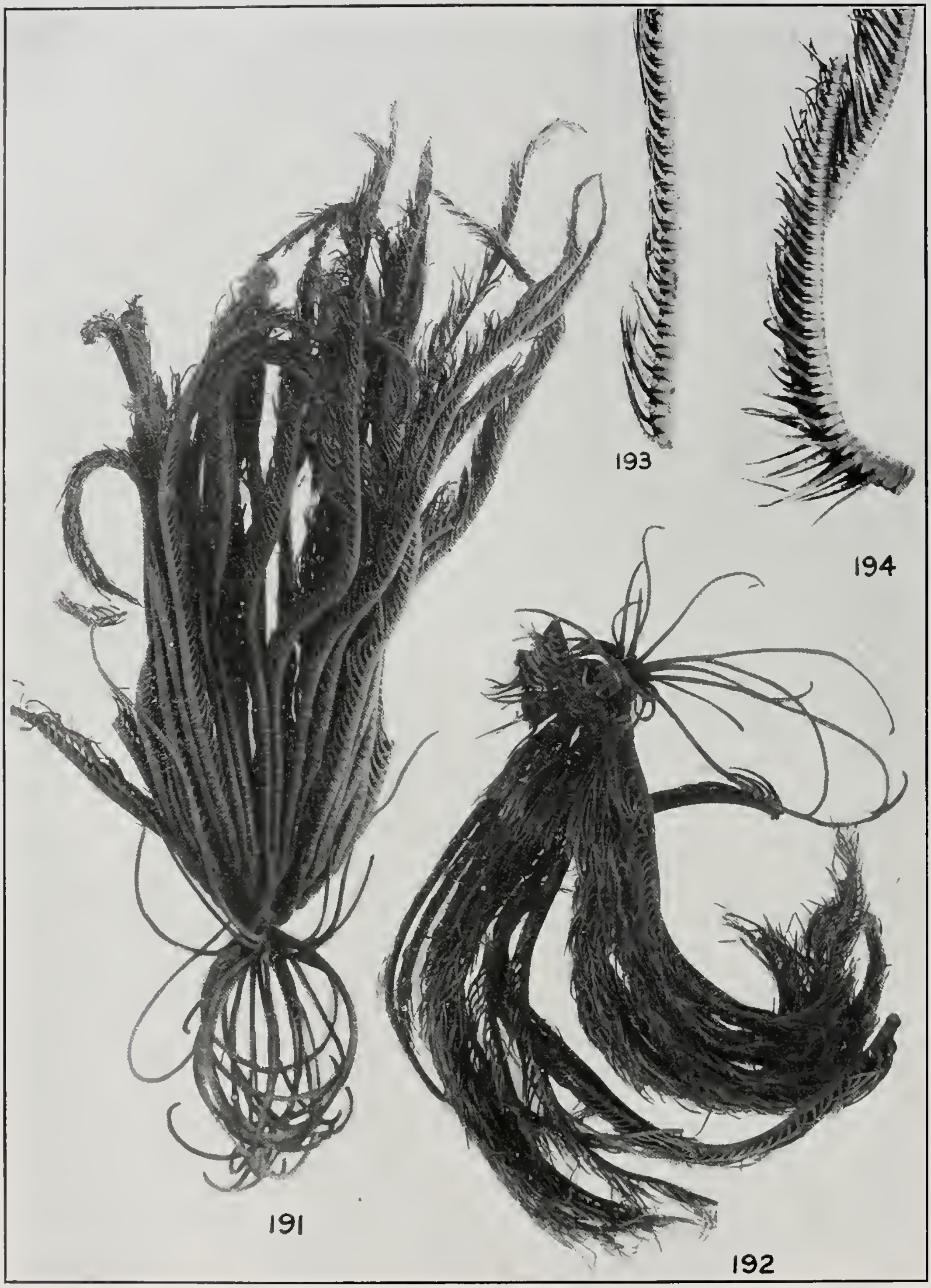


185–187, *Amphimetra tessellata tessellata:* 185, Specimen from Amboina, pier, in 0–2 meters, collected by the *Willebrord Snellius* (L. M.); 186, specimen from between Fremantle and Geraldton, Western Australia, in 110–183 meters (U.S.N.M., 35110); 187, proximal pinnules of a specimen from the Danish Expedition to the Kei Islands station 19, × 2 (U.S.N.M., E. 3179).

188, *Amphimetra tessellata discoidea:* Specimen from Port Denison, Queensland (Australian Mus.).

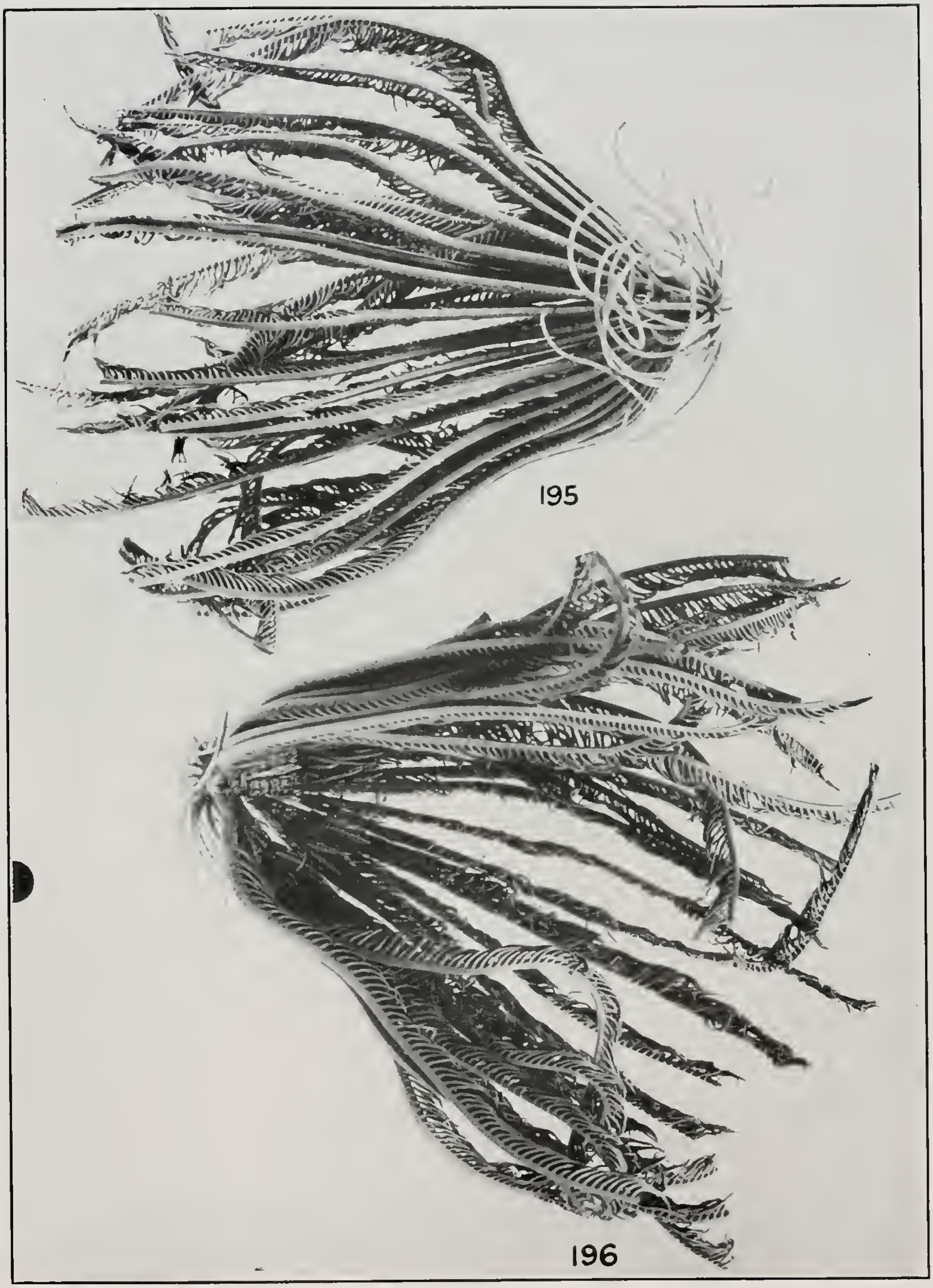


189, 190, *Oxymetra erinacea:* The type specimen from Cebu (H. M.).

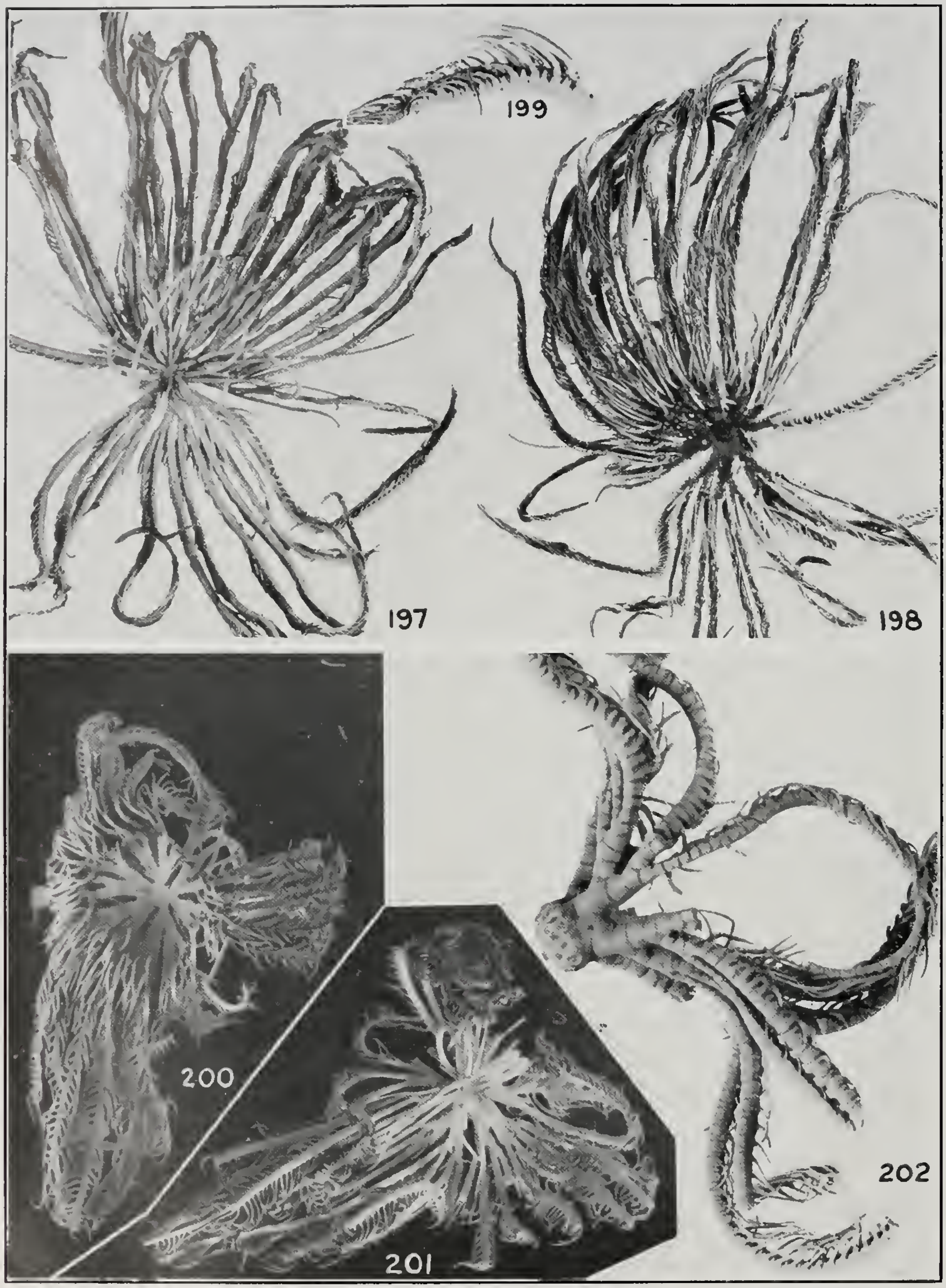


191–193, *Oxymetra finschii:* 191, The type specimen from New Britain (Berl. Mus.); 192, a cotype from New Britain (U.S.N.M., 35268); 193, same, proximal pinnules, × 2.

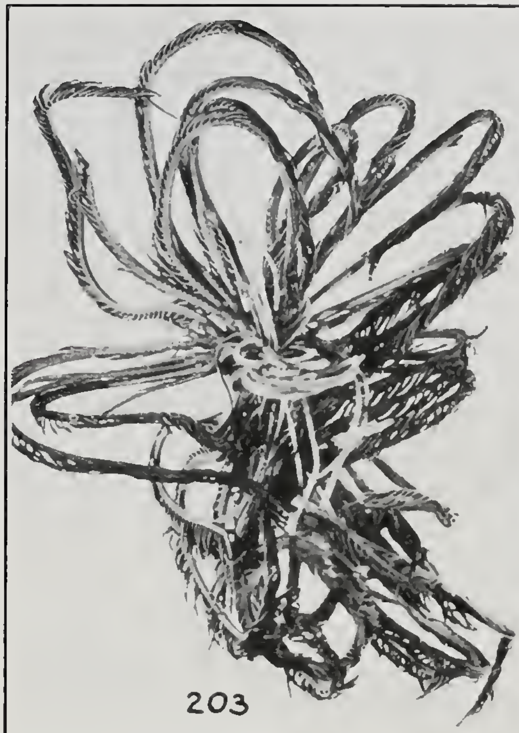
194, *Oxymetra erinacea:* Proximal pinnules of a specimen from the Danish Expedition to the Kei Islands station 90, × 2 (U.S.N.M., E. 3192).



195, 196, *Oxymetra tenuicirra:* The type specimen from *Siboga* station 320 (Amsterdam Mus.).



197–202, *Oxymetra finschii:* 197, 198, The type specimen of *Himerometra gracilipes* from *Albatross* station 5163 (U.S.N.M., 25455); 199, same, proximal pinnules, × 2; 200, 201, the type specimen of *Dichrometra aranea* from lat. 8°51′30″ N., long. 81°11′52″ E., in 51 meters (I. M.); 202, cotype of *Dichrometra aranea* from lat. 8°51′30″ N., long. 81°11′52″ E., in 51 meters, × 2 (U.S.N.M., 35241).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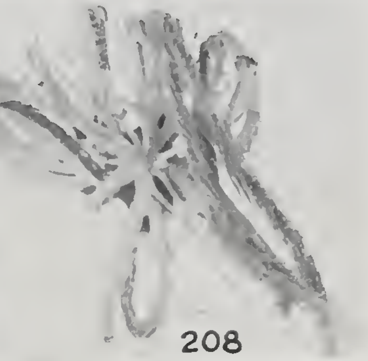
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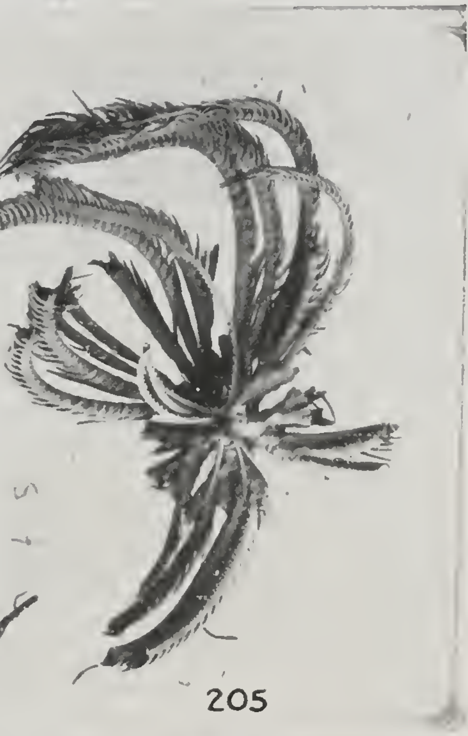
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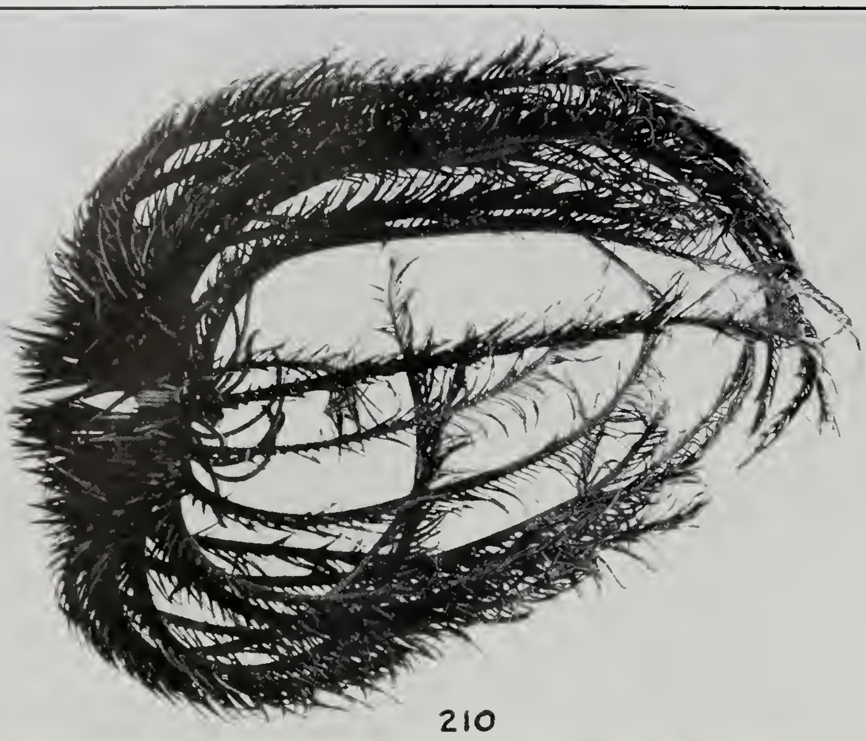
203, 204, *Oxymetra finschii:* 203, The type specimen of *Selenemetra viridis* from *Albatross* station 5413 (U.S.N.M., 27491); 204, same, proximal pinnules, × 2.

205–207, *Stephanometra echinus:* 205, The type specimen of *S. coronata* from "India" (I. M.); 206, 207, proximal pinnules of a specimen from Port Busin, Burias Island, Philippines, collected by the *Albatross*, × 2 (U.S.N.M., 35095).

208, 209, *Stephanometra tenuipinna:* The type specimen from Matupi, New Britain, × 2 (Berl. Mus.).



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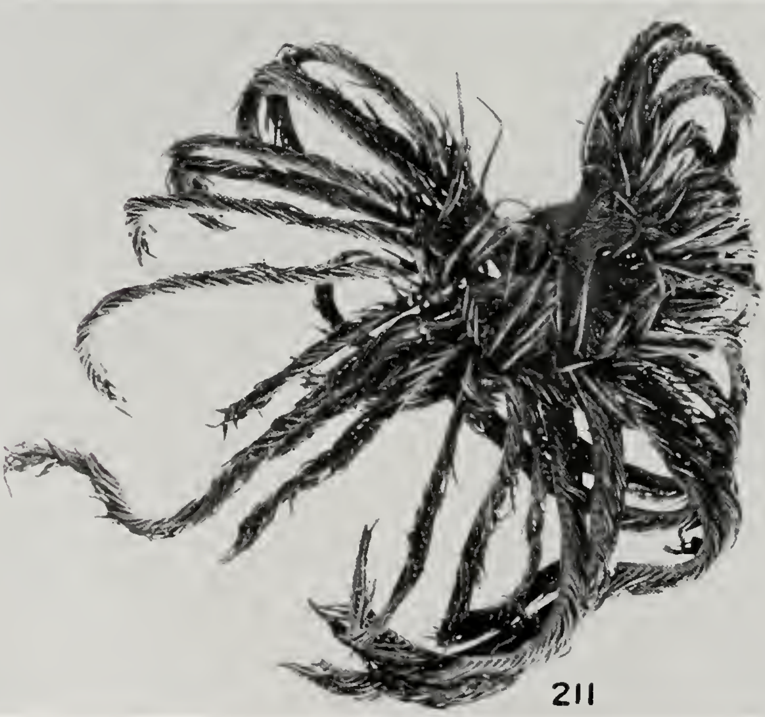

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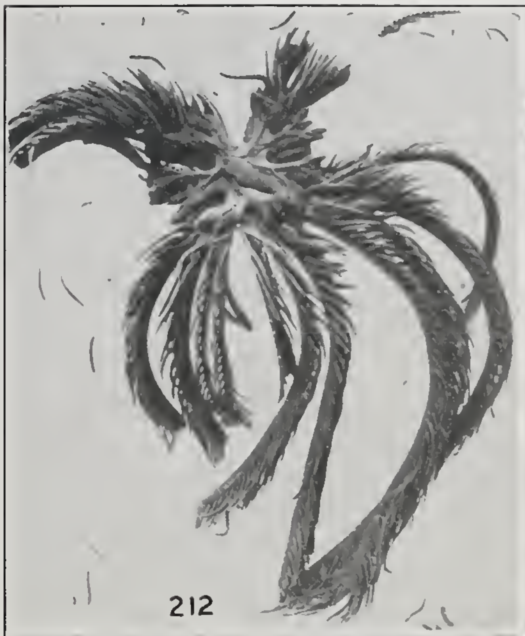
210, 211, *Stephanometra echinus:* 210, Specimen from *Albatross* station 5163 (U.S.N.M., 35269); 211, the type specimen from *Albatross* station 5147 (U.S.N.M., 25442).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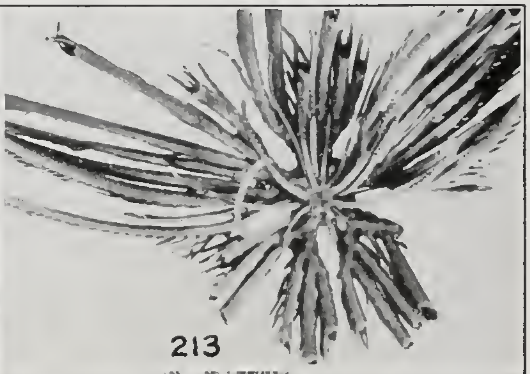
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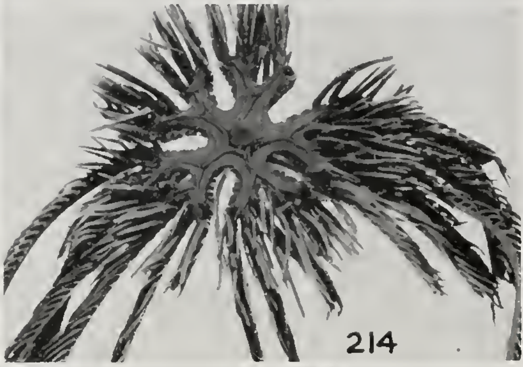
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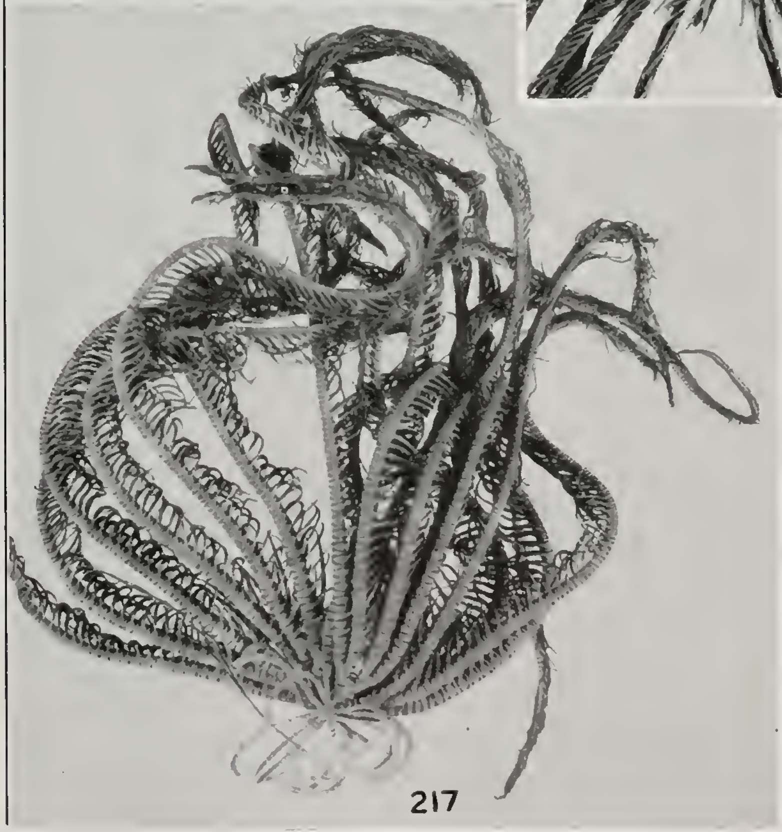
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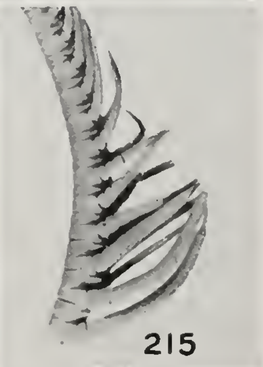
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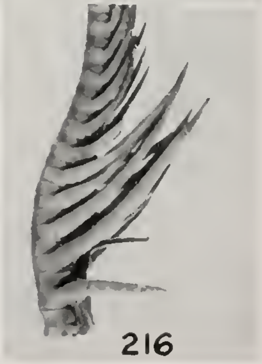
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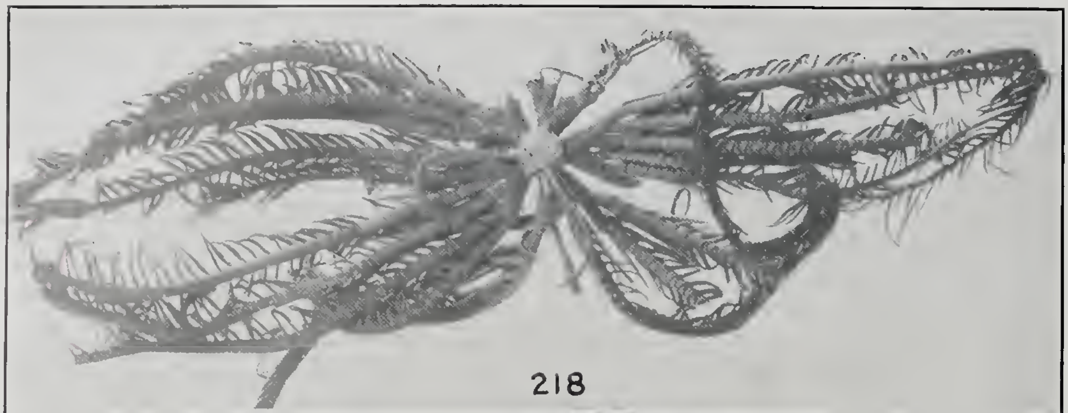
212–216, *Stephanometra echinus:* 212, The type specimen of *S. coronata* from "India" (I. M.) (see also fig. 205); 213, 214, a cotype of *S. coronata* from "India" (U.S.N.M., 35242); 215, same, proximal pinnules, × 2; 216, proximal pinnules of the type specimen from *Albatross* station 5147, × 2 (U.S.N.M., 25442).
217, *Stephanometra oxyacantha:* Specimen from Reede Bongao, in 27 meters, collected by the *Willebrord Snellius* (L. M.).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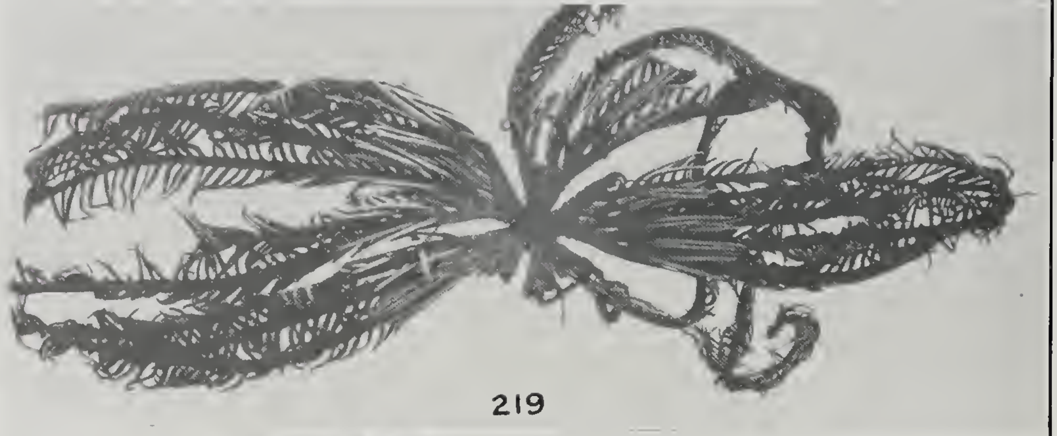
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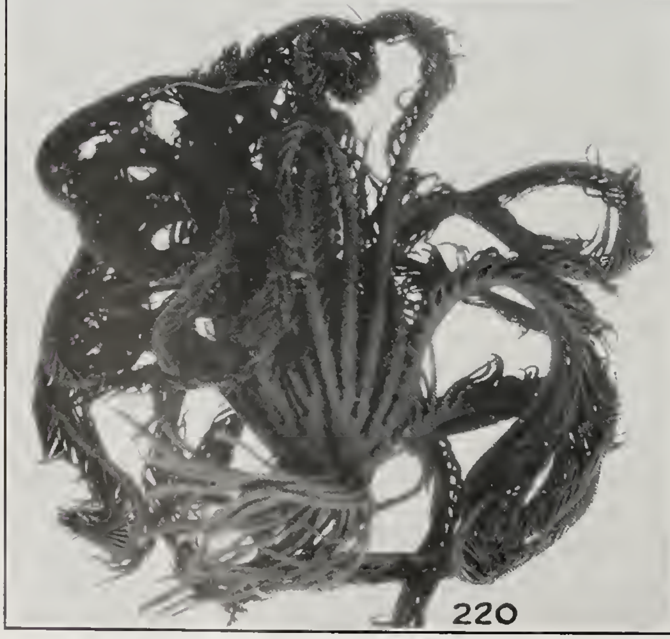
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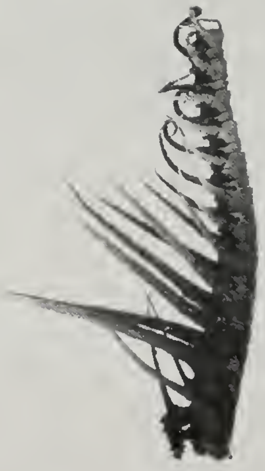
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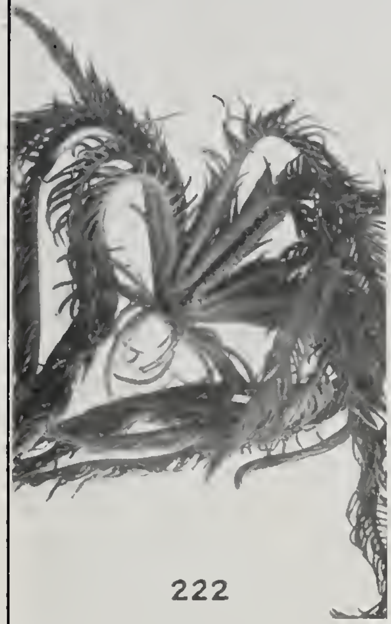
218–221, *Stephanometra oxyacantha:* 218, 219, A cotype from Amboina (H. M.); 220, a specimen from Amboina collected by the *Willebrord Snellius* (L. M.); 221, proximal pinnules of a specimen collected by the *Siboga* at Enkhuizen Island, × 2 (U.S.N.M., E. 469).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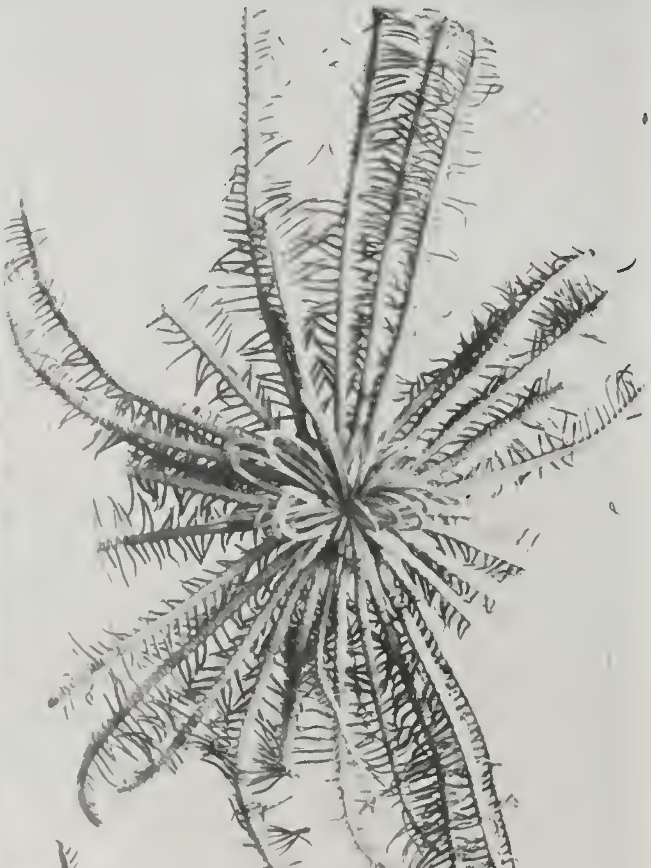
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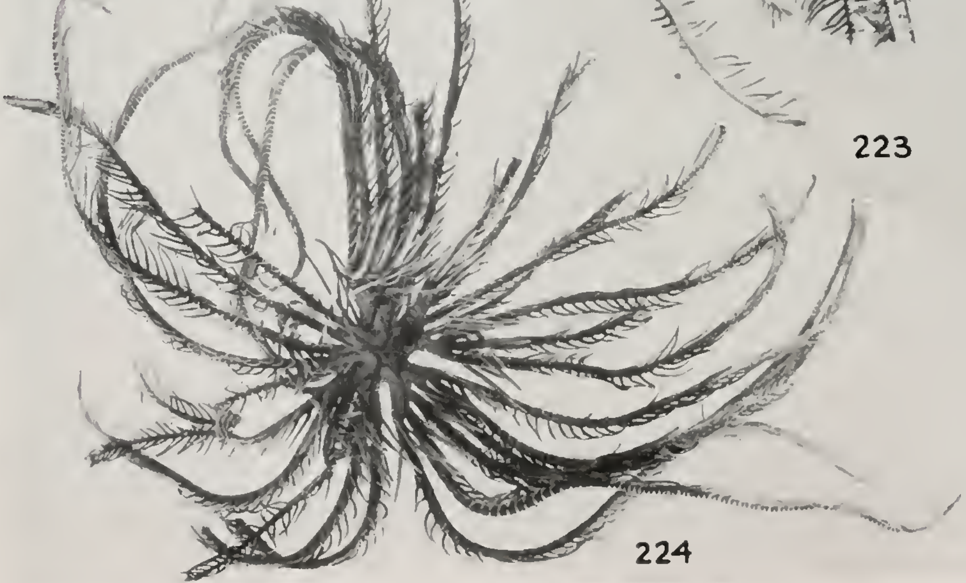
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222, *Stephanometra protectus*: Specimen from Singapore (C. M.).
223, 224, *Stephanometra spicata*: 223, Specimen from Ruk, Caroline Islands (H. M.); 224, specimen from Singapore (C. M.).

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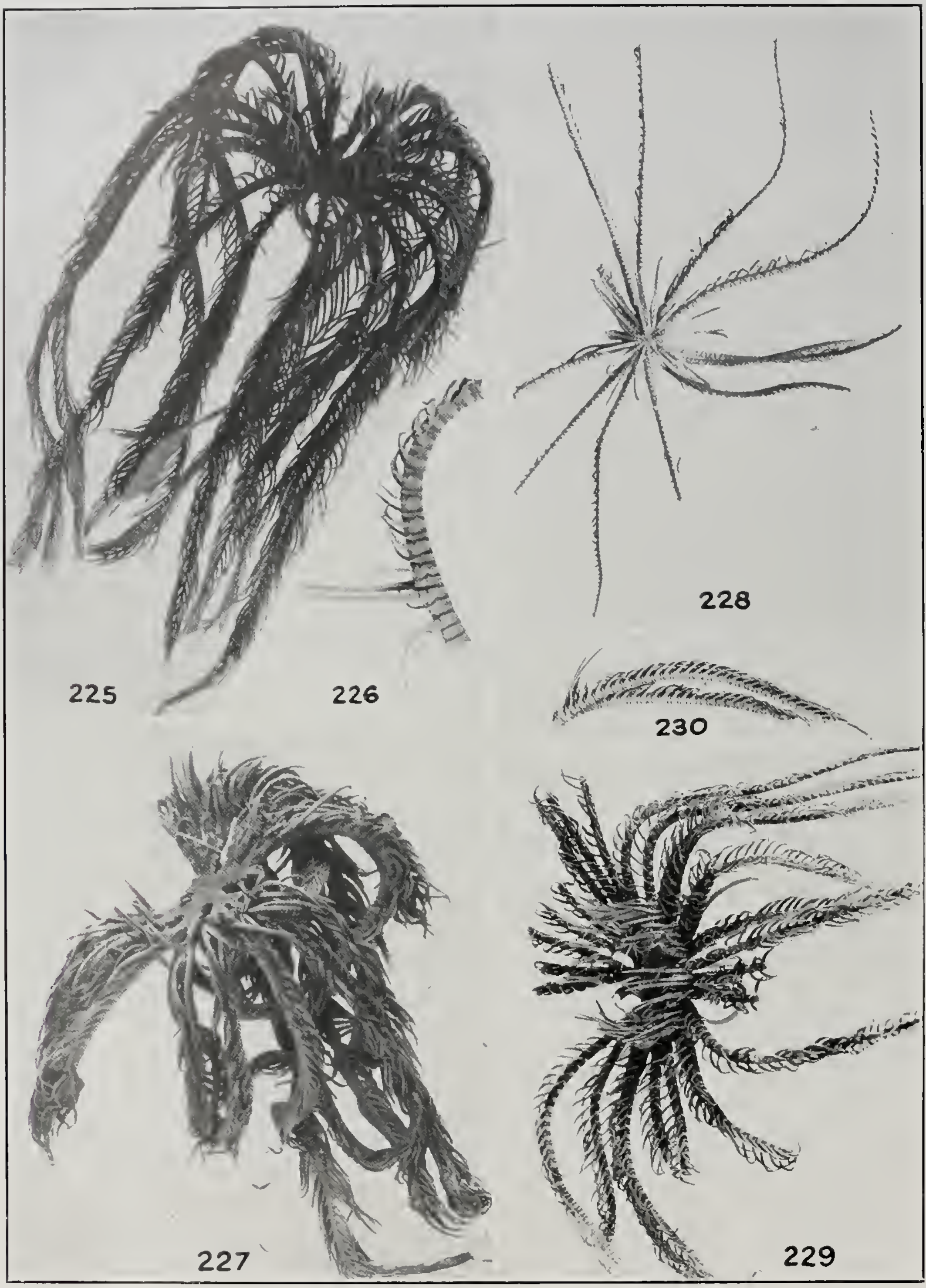
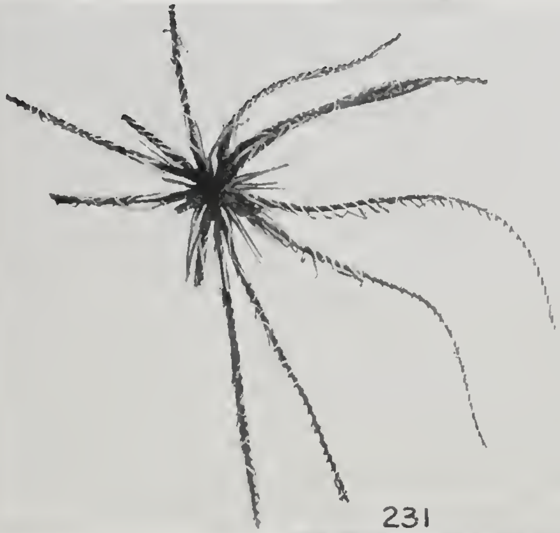


225–230, *Stephanometra protectus:* 225, Specimen from the Nicobar Islands identified by Prof. C. F. Lütken as *Antedon zebrinus* (C. M.); 226, proximal pinnules of a specimen from Port Blair, Andaman Islands, collected by the *Investigator*, × 2 (U.S.N.M., 35223); 227, the type specimen of *Himerometra heliaster* from Ebon, Marshall Islands (M. C. Z., 290); 228, the type specimen of *H. acuta* from Fiji (M. C. Z., 288); 229, specimen from Port Blair, Andaman Islands, collected by the *Investigator* (U.S.N.M., 35223); 230, proximal pinnules of a specimen from Addu Atoll, Maldive Archipelago, collected by the *Willebrord Snellius*, × 2 (L. M.).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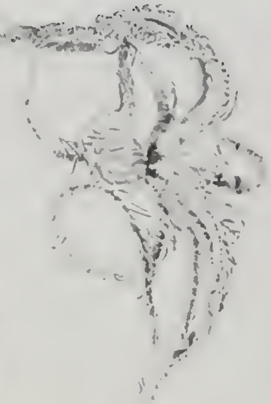
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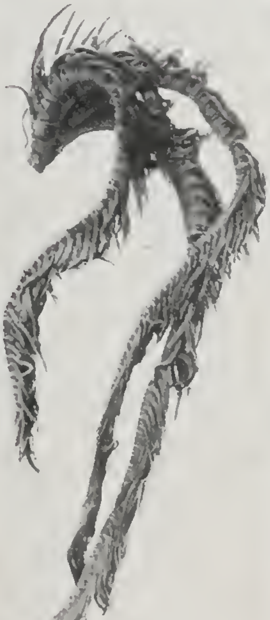
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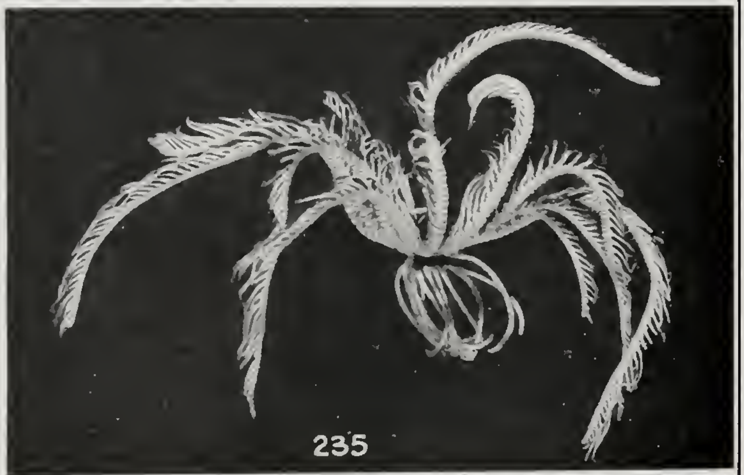
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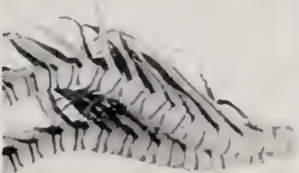
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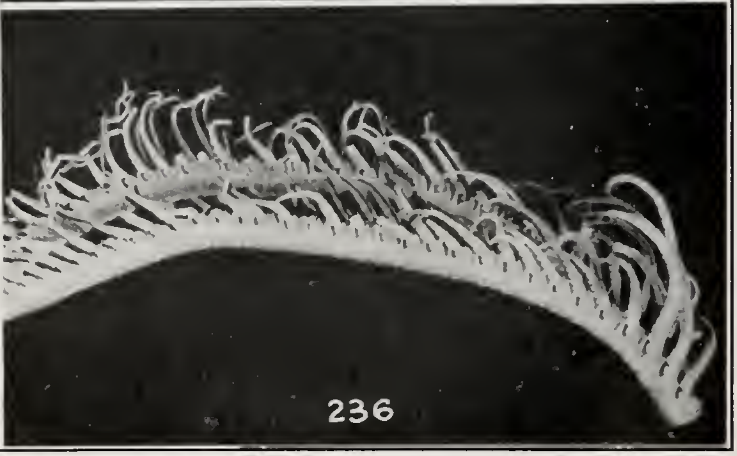
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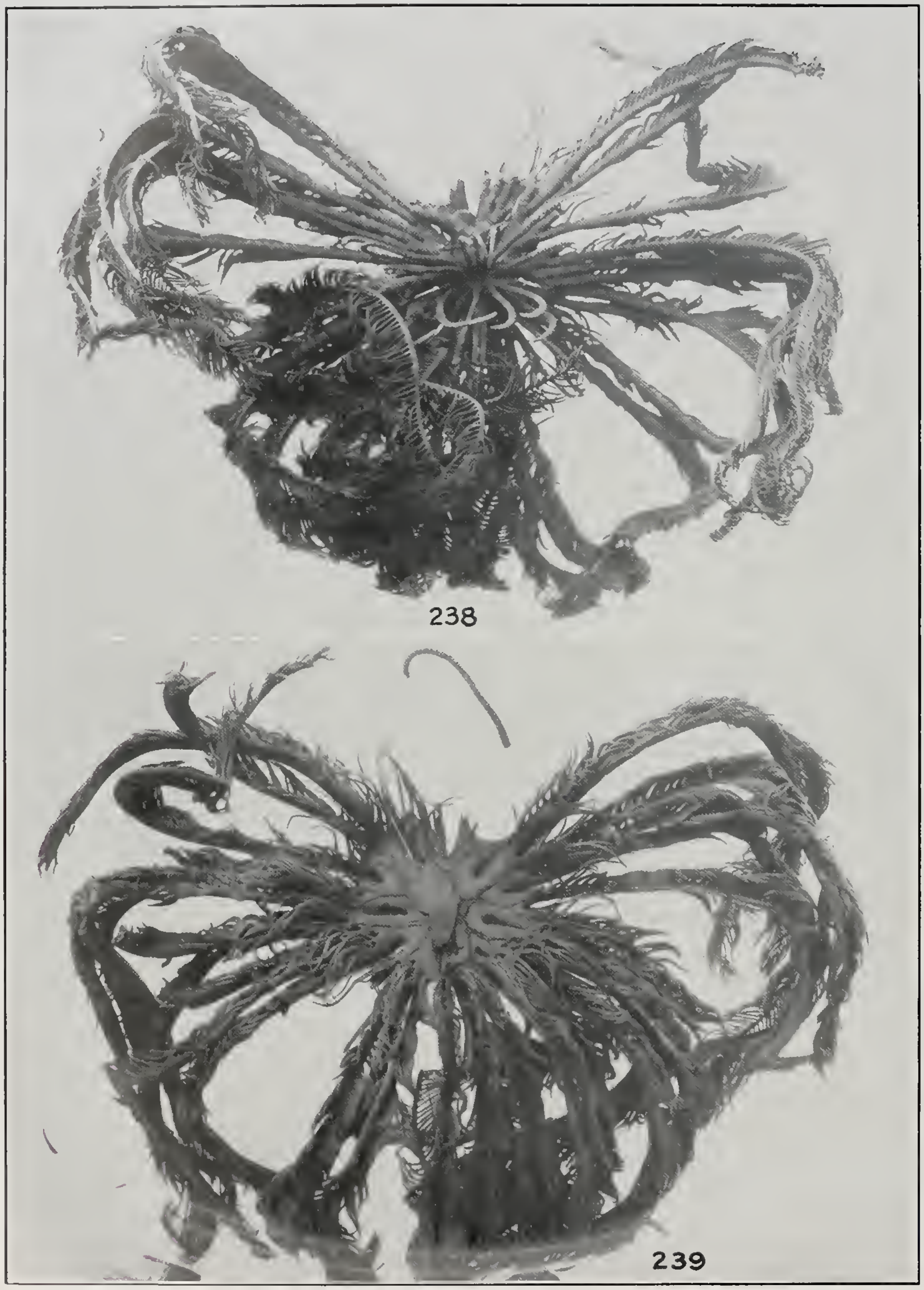
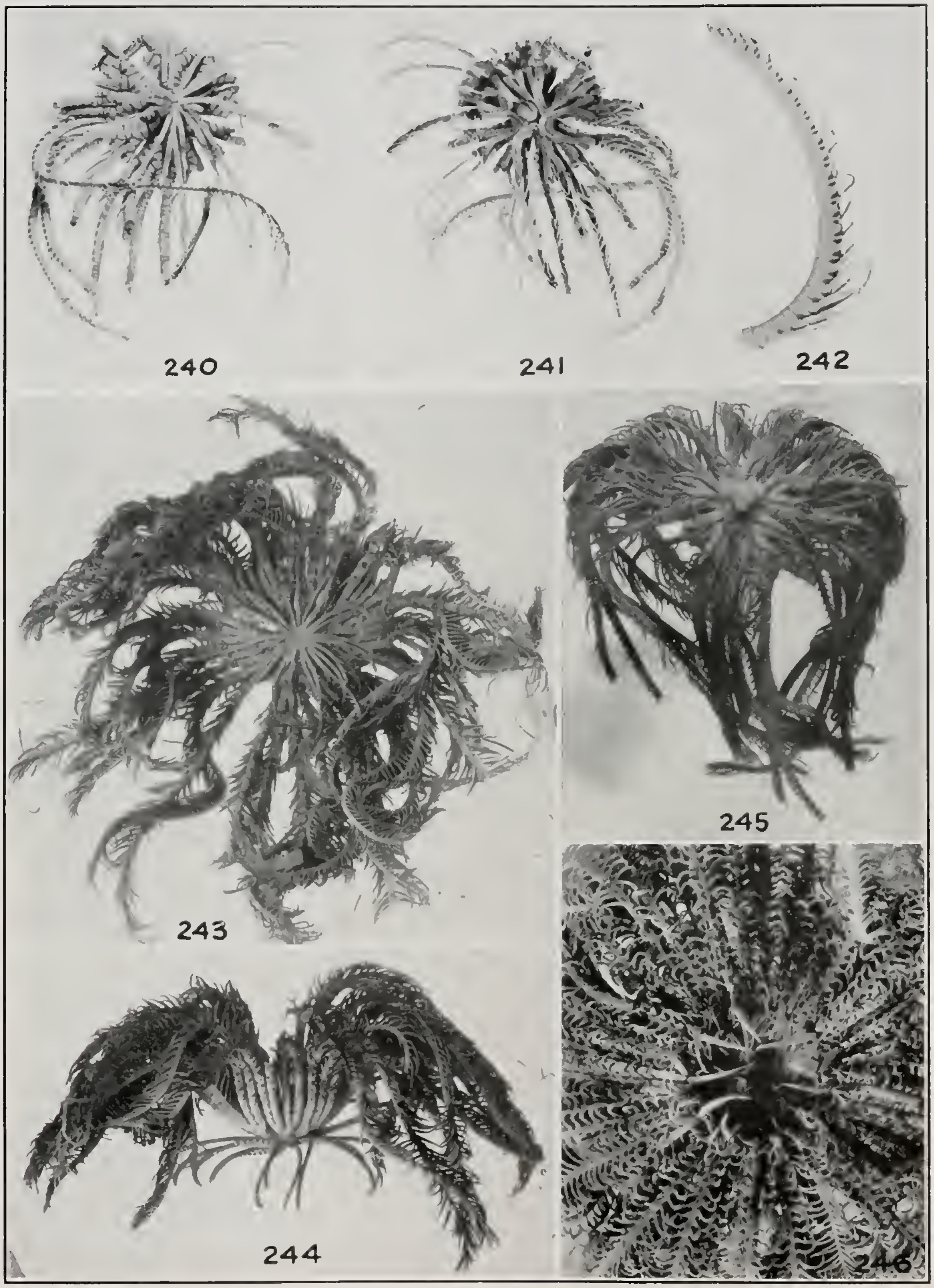
231, 232, *Stephanometra protectus:* 231, The type specimen of *Himerometra acuta* from Fiji (M. C. Z., 288) (see also fig. 228); 232, the type specimen of *H. heliaster* from Ebon, Marshall Islands, pinnules, × 2 (M. C. Z., 290) (see also fig. 227).

233, 234, *Stephanometra indica:* 233, Specimen from lat. 8°51′30″ N., long. 81°11′52″ E., in 51 meters, collected by the *Investigator* (U.S.N.M., 35107); 234, same, proximal pinnules, × 2.

235–237, *Pelometra ambonensis:* 235, The type specimen collected by the Danish Expedition to the Kei Islands at Amboina (C. M.); 236, 237, same, pinnules, × 2.

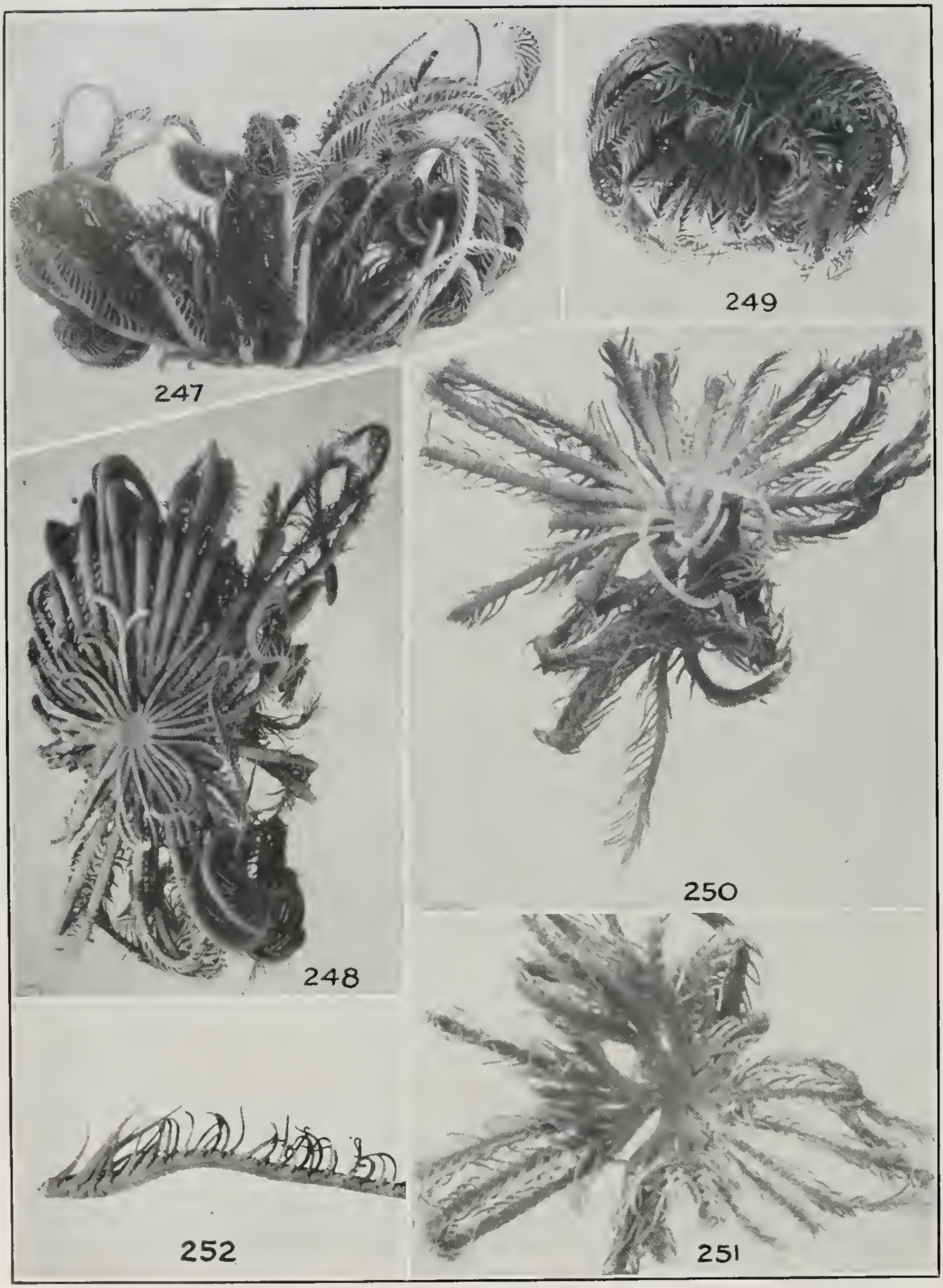


238, 239, *Liparometra grandis:* The type specimen from Hirado Strait, Japan, in 73 meters (C. M.).

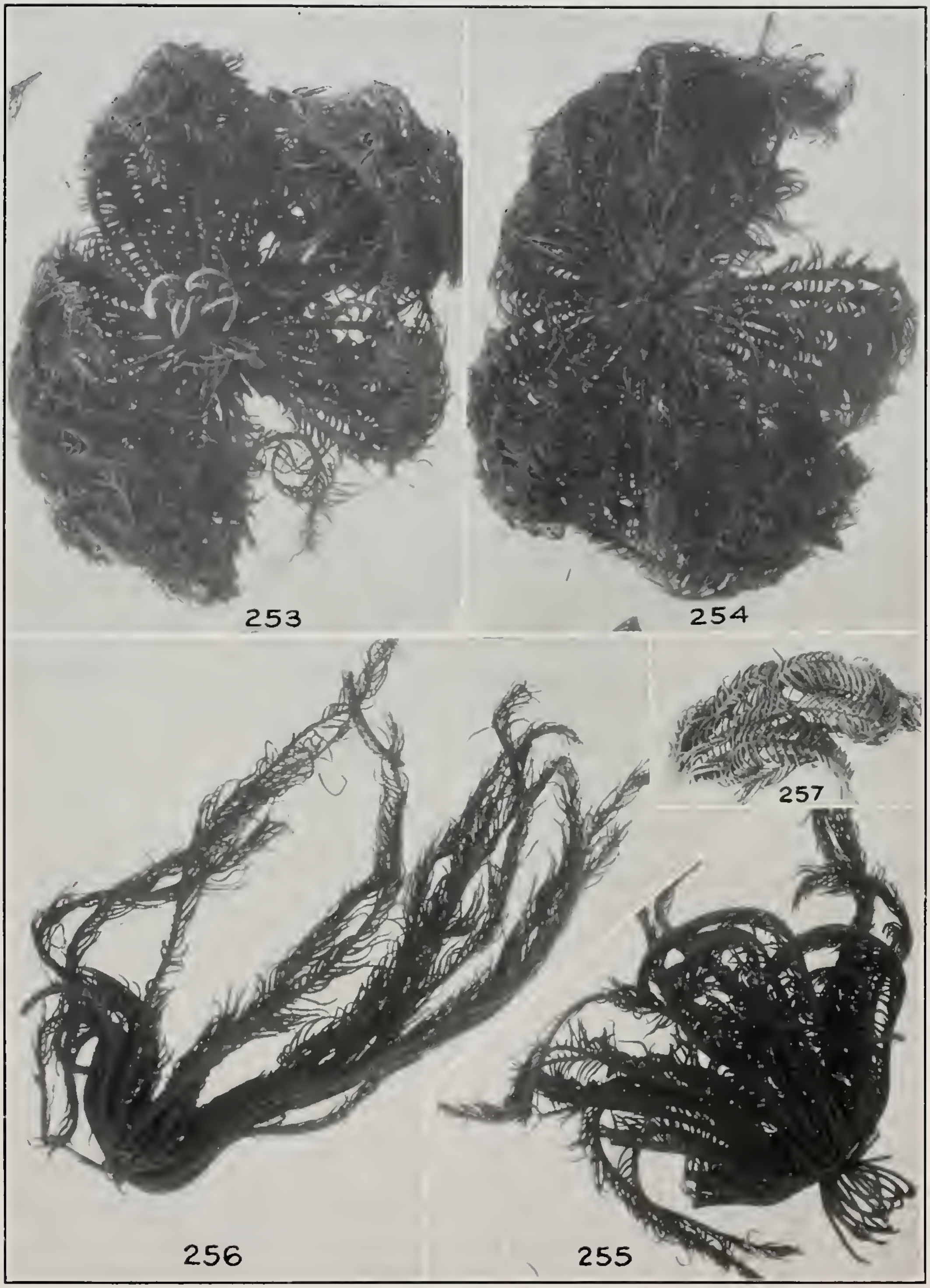


240–242, *Liparometra articulata:* 240, 241, Specimen from *Siboga* station 49a (U.S.N.M., E. 387); 242, same, proximal pinnules, × 2.

243–246, *Lamprometra palmata palmata:* 243, 244, Two specimens from Singapore (C. M.); 245, specimen from New Guinea (Berl. Mus.); 246, the central portion of a very large specimen, ventral view, from *Siboga* station 115, reef (Amsterdam Mus.).



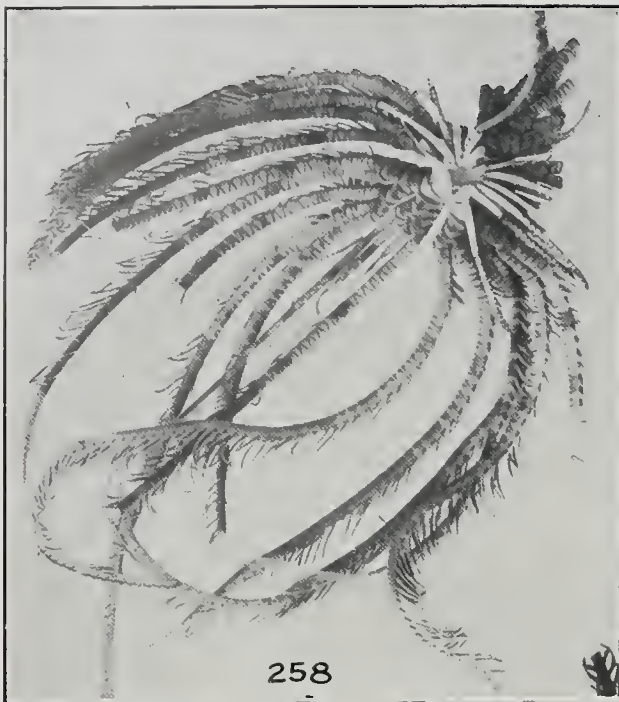
247–252, *Lamprometra palmata palmata:* 247, 248, The type specimen of *Antedon aequipinna* from an unknown locality (H. M.); 249, specimen from Mortlock Island, Carolines (H. M.); 250, 251, the type specimen of *Antedon lepida* from the Tonga Islands, × 2 (H. M.); 252, proximal pinnules of a specimen from Paleleh, collected by the *Willebrord Snellius*, × 2 (U.S.N.M., E. 5273).



253–255, *Lamprometra palmata gyges:* 253, 254, Specimen from Port Denison, Queensland (C. M.); 255, specimen from Bowen, Queensland (C. M.).

256, *Lamprometra klunzingeri:* Specimen from the Red Sea, collected by Hemprich and Ehrenberg (Berl. Mus.).

257, *Lamprometra palmata palmata:* Pinnules of the specimen from Mortlock Island shown in fig. 249.



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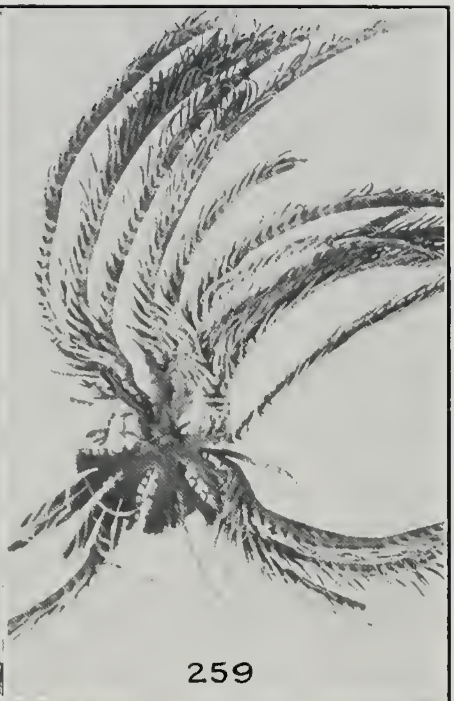

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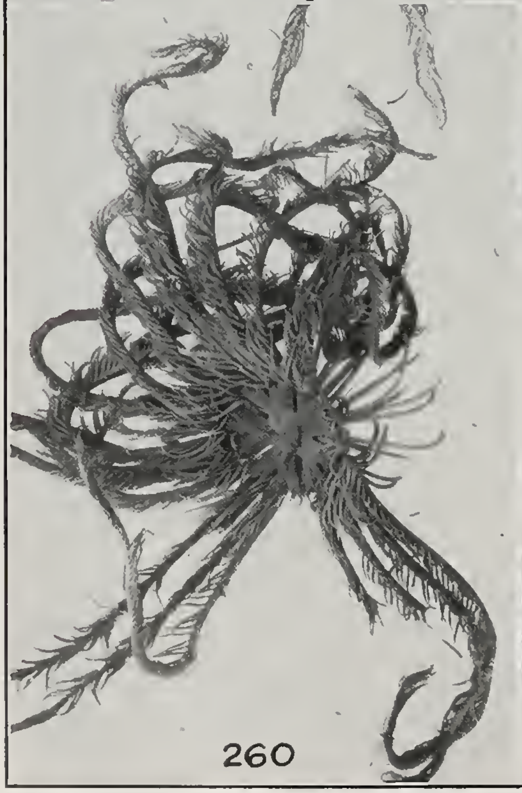

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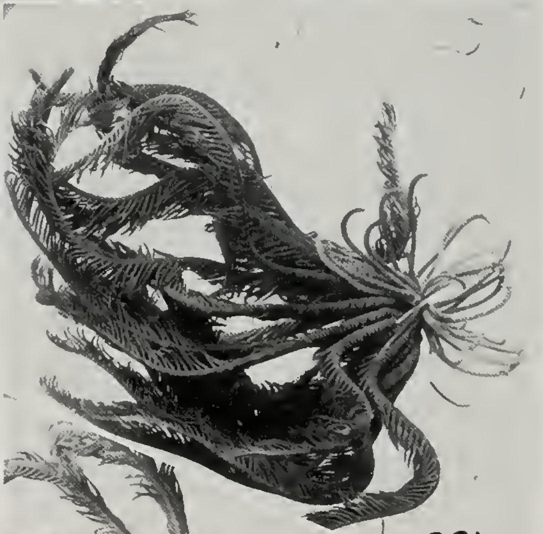

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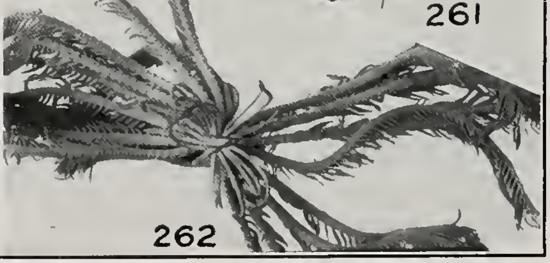

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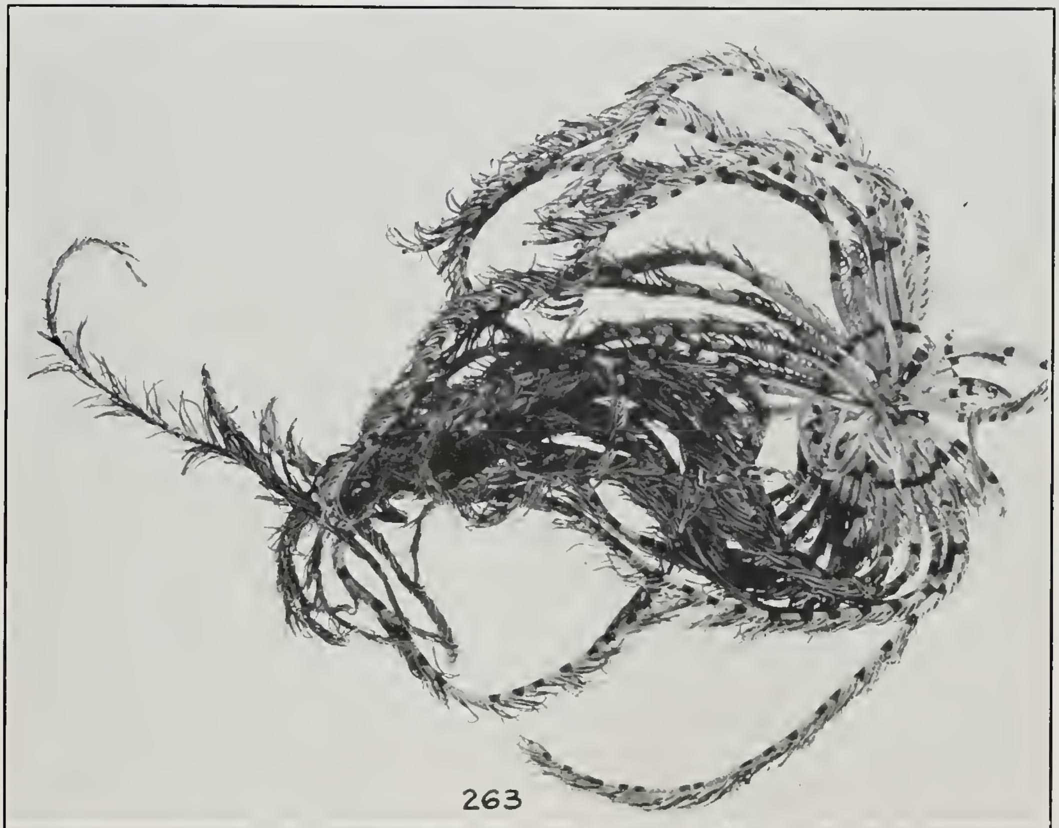
258–262, *Dichrometra flagellata:* 258, 259, Specimen from the Pelew Islands identified by Dr. C. F. Lütken as *Antedon pulcher* (H. M.); 260–262, three specimens from Singapore (C. M.).



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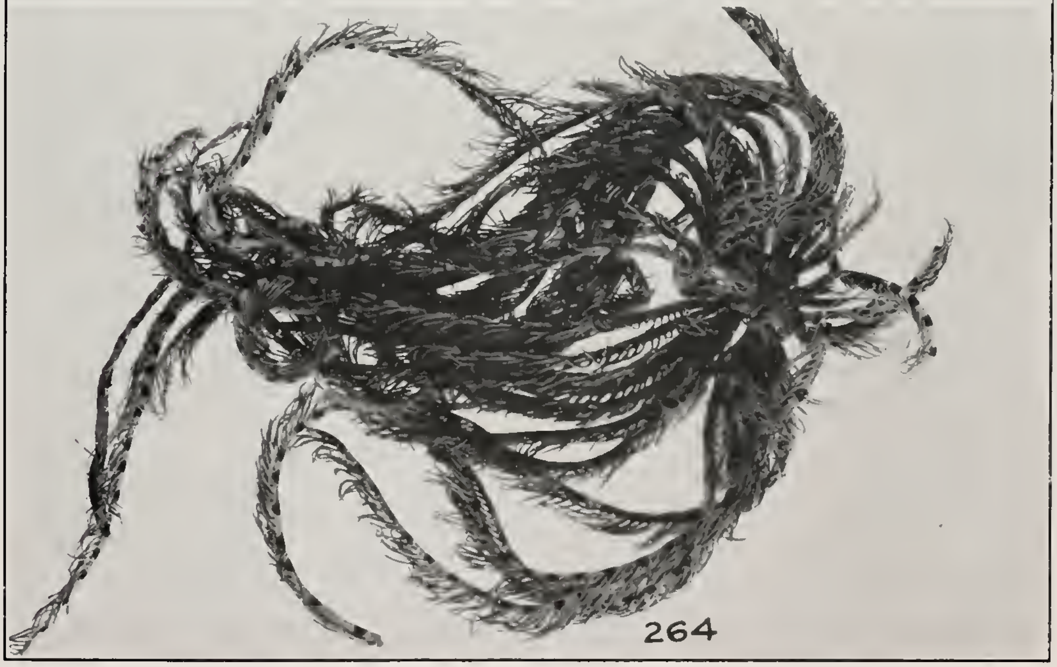

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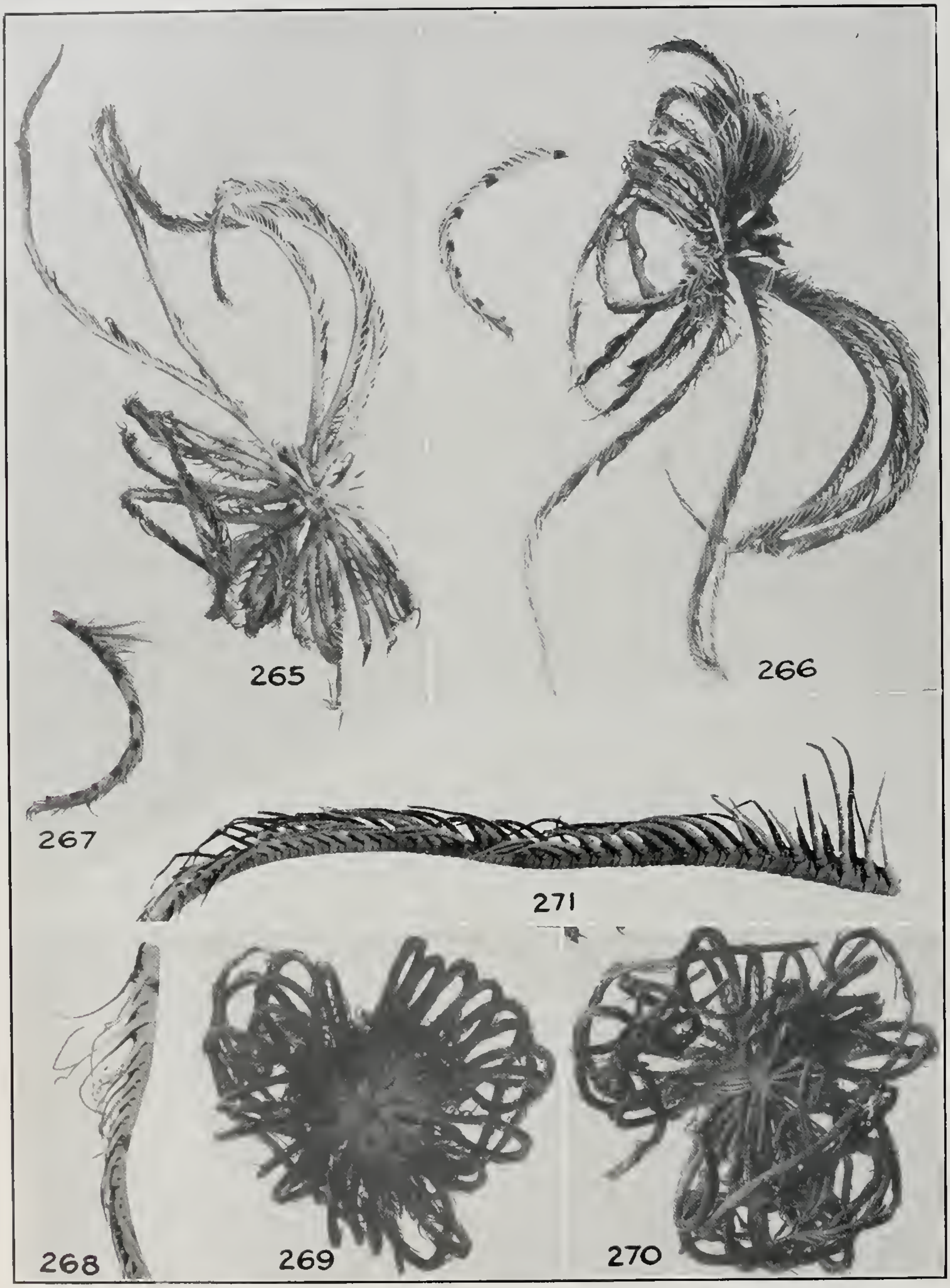
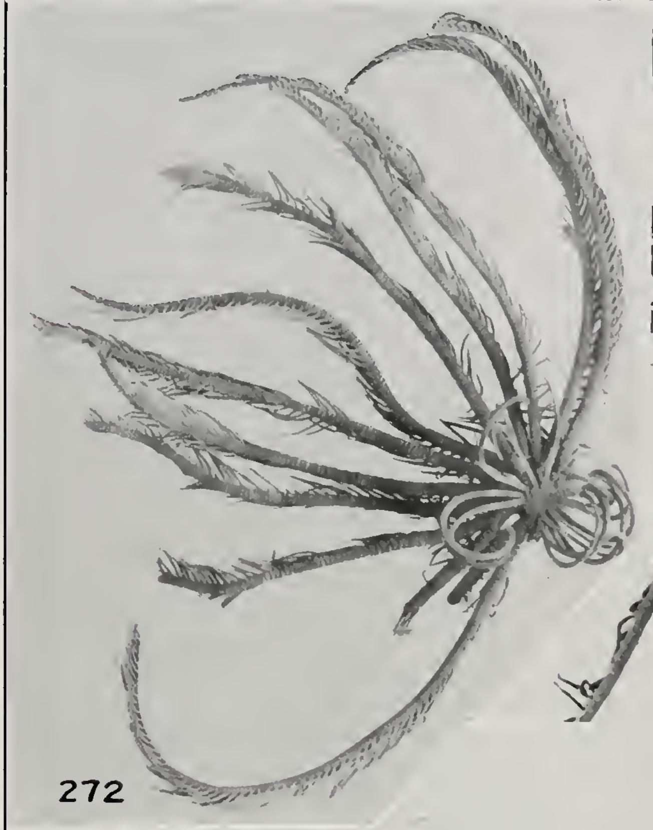
263, 264, *Dichrometra ciliata:* A cotype collected by the *Golden Crown* off Gopalpore in 55–69 meters (U.S.N.M., 35258).



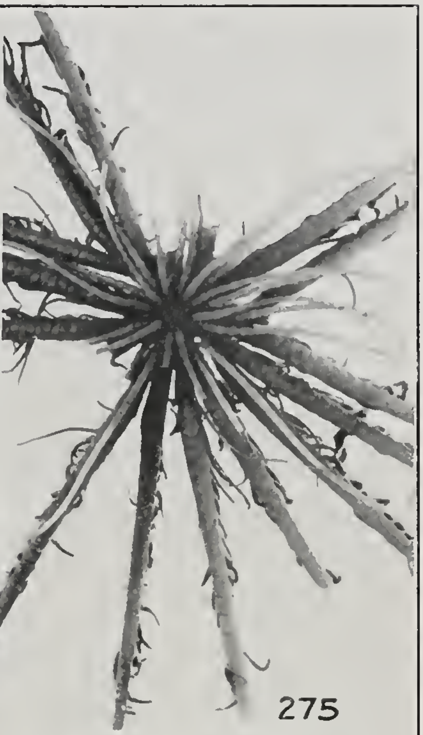
265-268, *Dichrometra ciliata:* 265, 266, The type specimen from off Gopalpore in 55-69 meters, collected by the *Golden Crown* (I. M.); 267, same, proximal pinnules; 268, proximal pinnules of the cotype shown in figs. 263, and 264, × 2.

269, 270, *Dichrometra afra:* The type specimen from Madagascar (H. M.).

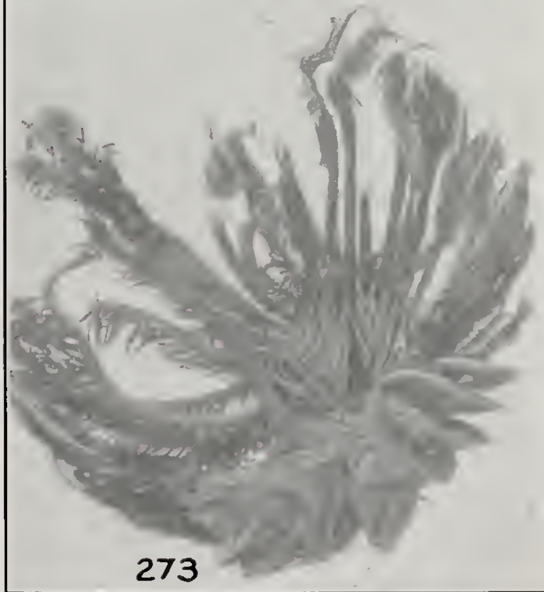
271, *Dichrometra döderleini:* Proximal pinnules of a specimen from Kagoshima Bay, Japan, × 2 (U.S.N.M., 35257).



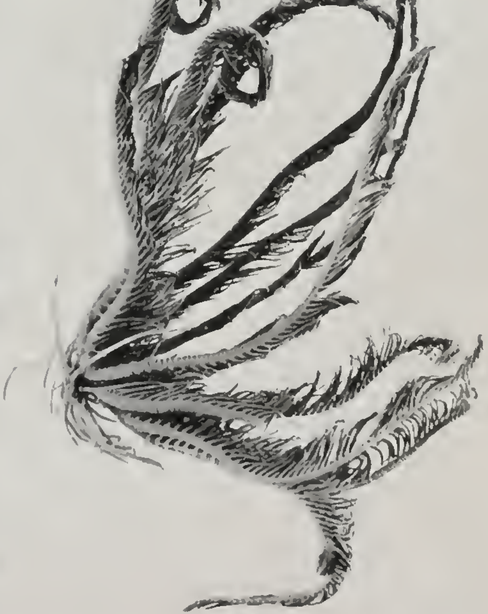
272



275



273

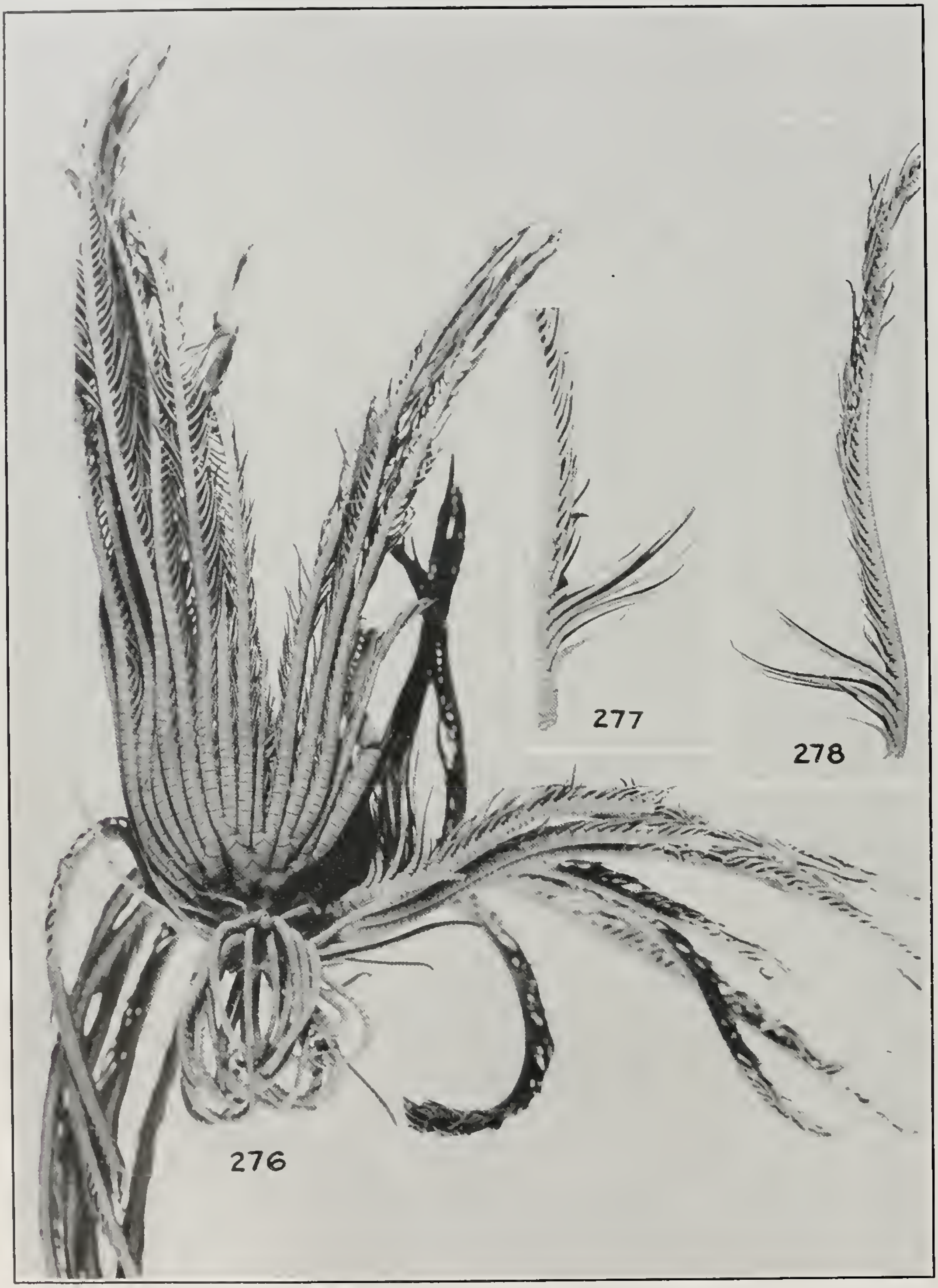


274

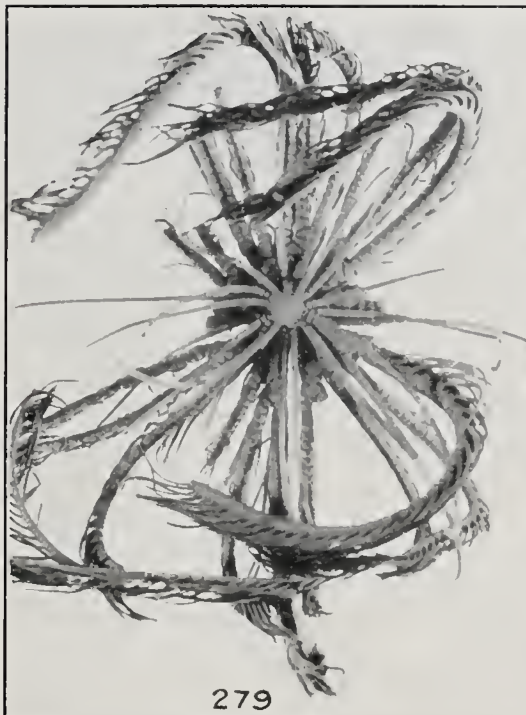
272, 273, *Dichrometra döderleini:* 272, Specimen from Kahoshima Bay, Japan (U.S.N.M., 35257) (see also fig. 271); 273, specimen from eastern Asia (probably the Korean Straits) (C. M.).

274, *Dichrometra stylifer:* The type specimen from *Albatross* station 4929 (U.S.N.M., 22645).

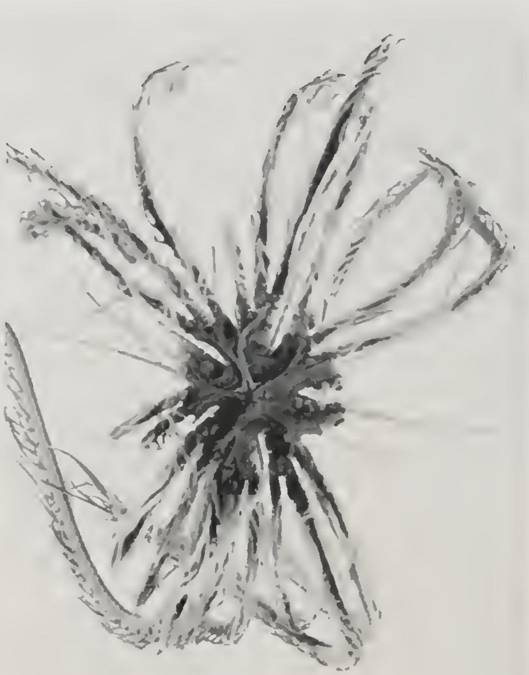
275, *Dichrometra tenuicirra:* The type specimen from *Siboga* station 320 (Amsterdam Mus.).



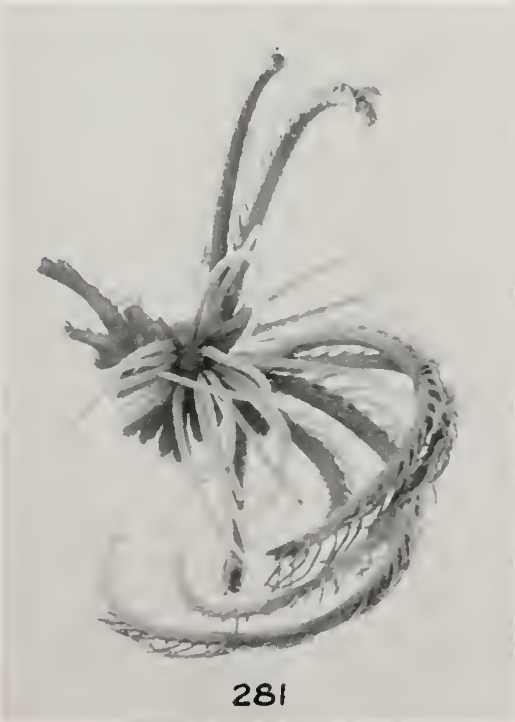
276–278, *Mariametra subcarinata:* 276, The type specimen from *Albatross* station 4880, × 2 (U.S.N.M.,22666); 277, 278, same, proximal pinnules, × 2.



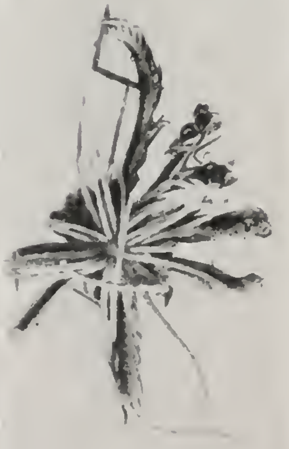
279



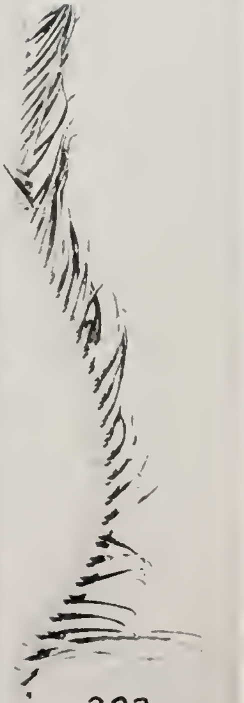
280



281



282



283

279, 280, *Mariametra delicatissima:* The type specimen from *Albatross* station 4930, × 2 (U.S.N.M., 22646).

281, *Mariametra tuberculata:* The type specimen from *Siboga* station 51, × 2 (Amsterdam Mus.).

282, *Mariametra tenuipes:* The type specimen from *Siboga* station 294, × 2 (Amsterdam Mus.).

283, *Dichrometra stylifer:* Proximal pinnules of the type specimen from *Albatross* station shown in fig. 274, × 2.

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